SURPLUS

OPERATION and MAINTENANCE

CUMMINS

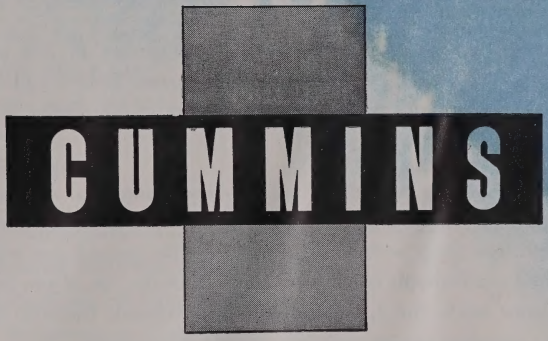
J, JS and JT DIESEL ENGINES

BULLETIN NO. 983346

PRICE 1.00

CUMMINS ENGINE COMPANY, INC. • COLUMBUS, INDIANA, U.S.A.

OPERATION and MAINTENANCE



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FOREWORD

Cummins J, JS and JT Engines described in this manual are four-stroke-cycle full-diesel engines equipped with the exclusive Cummins PT Fuel System. All three engines are treated in this one manual because the operating characteristics and service procedures are identical or very similar. Where different procedures are required, they are clearly indicated.

The operating and maintenance procedures described in this manual will enable you to get the best service from your engine. Before you operate the engine and before you attempt any adjustments on it, familiarize yourself with these instructions.

Because this is an operation and maintenance manual no atttempt is made to cover engine or unit rebuilding. Rebuild operations should be performed in a well-equipped shop with mechanics especially trained for rebuild work. These facilities are available from your Cummins Dealer. Or, if you are equipped to do your own work, the J, JS and JT Shop Manual, Bulletin No. 6395, is available for complete engine and unit rebuild instructions.

Your Cummins Dealer is always ready to serve you. He will give you any service information you require, and he has the genuine Cummins parts and shop facilities necessary for any service job.

CUMMINS ENGINE COMPANY, INC.
COLUMBUS, INDIANA

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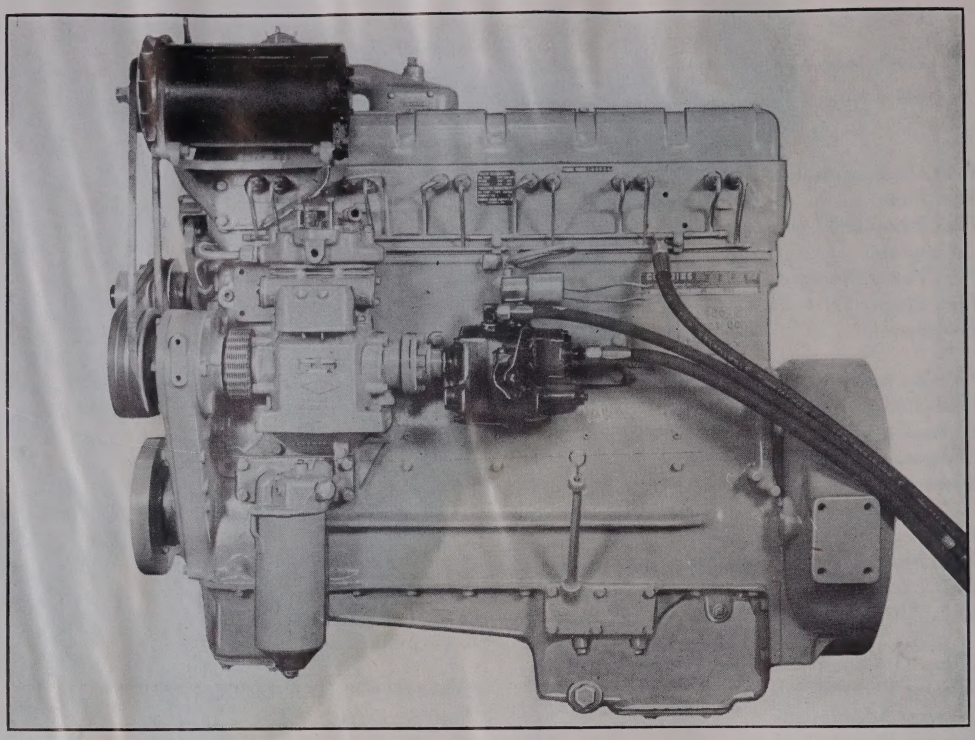

Fig. 1. Cummins JS Diesel Engine—Fuel Pump Side

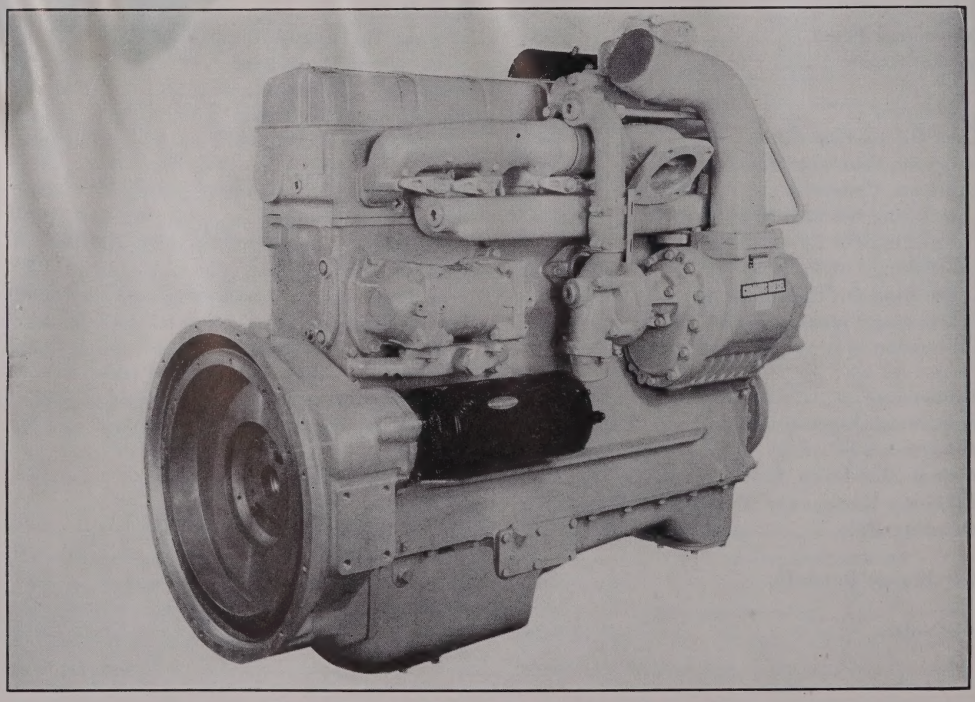

Fig. 2. Cummins JS Diesel Engine—Supercharger Side

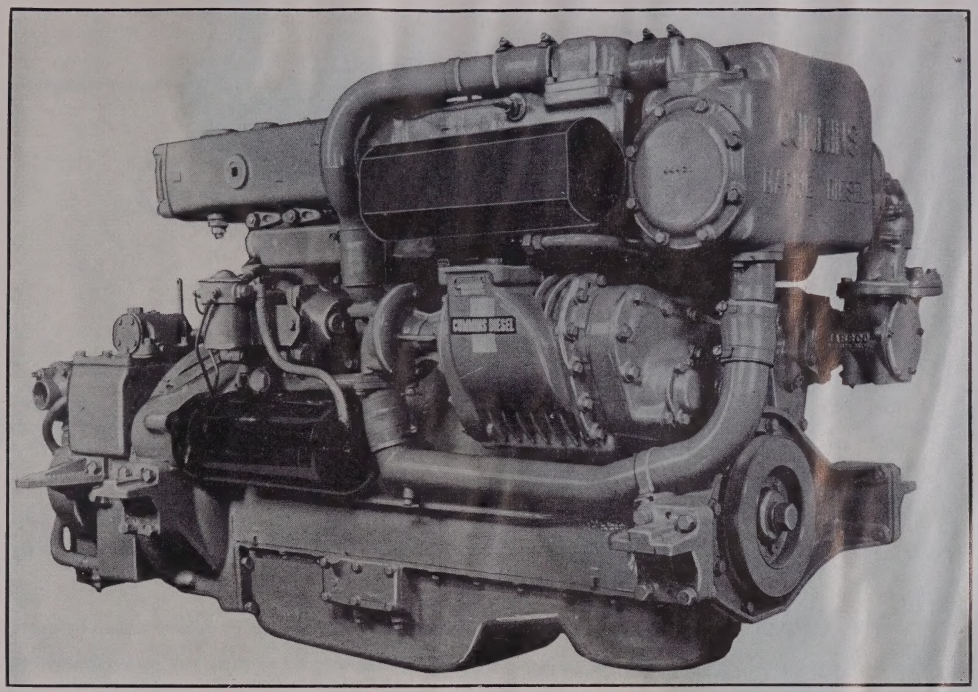

Fig. 3. Cummins JMS Marine Diesel Engine, Supercharger Side

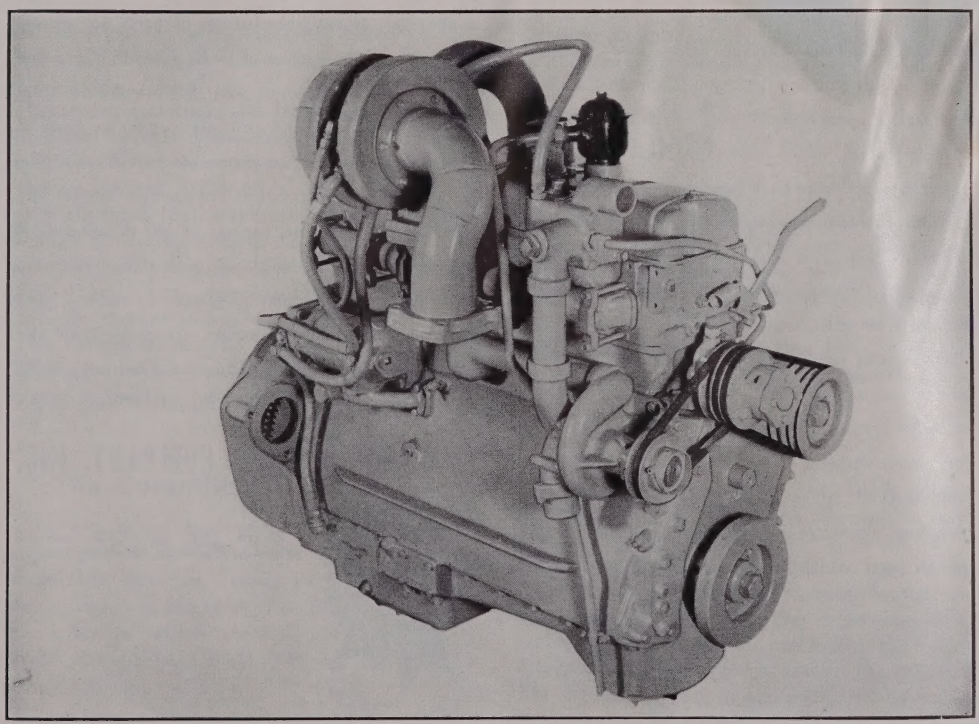

Fig. 4. Cummins JT Diesel Engine—Turbocharger Side

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100,000 MILES OR ONE YEAR

THE ENGINES FURNISHED BY

CUMMINS ENGINE COMPANY, INC.

are warranted to be free from any defects in workmanship and material under normal use and service, our obligation under this Warranty being limited to replacing or repairing at our factory in Columbus, Indiana, any part or parts returned to us with transportation charges prepaid, which our examination shall disclose to our satisfaction to have been thus defective, within the first twelve months or the first 100,000 miles of operation, whichever shall first occur, from date of delivery of the engine to the original purchaser, this Warranty being expressly in lieu of all other Warranties express or implied and of all other obligations or liabilities on our part. We neither assume nor authorize any other person to assume for us any other liability in connection with the sale of our engines. ¶ This Warranty shall not apply to any part or parts which shall have been altered or repaired outside of our factory, nor to parts which have been subjected to misuse, abuse, neglect, accident or to damage caused by overspeeding, nor to part or parts not manufactured or approved by us, nor to part or parts of engines improperly applied or installed. Any improper installation or application, or any substitution of parts not manufactured or approved by us, shall void all Warranties express or implied on our part. ¶ We make no Warranty as to normal wear and tear, nor do we agree to be liable for loss of time to the user while the engine or other equipment is out of commission, nor for any labor or other expense, damage or loss occasioned, or claimed to be occasioned, by such defective parts. ¶ We make no Warranty in respect to starters, generators, transmissions, clutches, compressors, or any accessories not manufactured by us. These are usually warranted by their respective manufacturers.

CUMMINS ENGINE COMPANY, INC.

CUMMINS ENGINE COMPANY, INC. SEAL COLUMBUS, IND.

R. E. Huthsteiner

PRESIDENT

Operation and Maintenance

CUMMINS

J, JS, JT DIESEL ENGINES

SECTION I

Principles of Operation

The most satisfactory service can be expected from a Cummins Diesel Engine when the operation and maintenance procedures are based upon a clear understanding of the engine working principles. Each part of the engine affects the operation of every other working part and of the engine as a whole.

Cummins J, JS and JT Diesel engines treated in this manual are four-stroke-cycle, high-speed, full-diesel engines. Horsepower ratings and other engine specifications for each model are tabulated in Section III of this manual.

Diesel engines differ from other internal combustion engines in a number of ways. Compression ratios are much higher than in spark-ignited engines. The charge taken into the combustion chamber through the intake consists of air only—with no fuel mixture. Injectors receive low pressure fuel from the fuel pump and deliver it into the individual combustion chambers at the right time in equal quantity and proper condition to burn. Ignition of fuel is caused by the heat of the compressed air in the combustion chamber.

We should understand the fuel system and the other features that are different in the Cummins Diesel from other internal combustion engines so that we can operate and maintain the Cummins Engine to the best advantage.

The Cummins Diesel Cycle

We can better understand the function of engine parts if we know what happens in the combustion chamber during each of the four piston strokes of the cycle. The four strokes and the order in which they occur are: Intake Stroke, Compression Stroke, Power Stroke and Exhaust Stroke.

INTAKE STROKE: During the intake stroke, the piston travels downward, the intake valve is open, and the exhaust valve is closed.

The downstroke of the piston permits air from outside to enter the cylinder through the open intake valve port. The supercharger or turbocharger increases air pressure in the engine intake manifold and forces it into the cylinder. The intake of air is never restricted by valves

such as those used on spark-ignited, automotive-type gasoline engines.

The intake charge consists of air only with no fuel mixture.

COMPRESSION STROKE: At the end of the intake stroke, the intake valve closes and the piston starts upward on the compression stroke. The exhaust valve remains closed.

At the end of the compression stroke, the air in the combustion chamber has been forced by the piston to occupy a space only one-fifteenth as great in volume as it occupied at the beginning of the stroke. Thus, we say the compression ratio is 15:1.

Compressing the air into a small space causes the temperature of that air to rise. Near the end of the compression stroke, the pressure of the air above the cylinder is approximately 500 to 600 pounds per square inch and the temperature of that air is approximately 1000° F.

During the last part of the compression stroke and the early part of the power stroke, a small metered charge of fuel is injected into the combustion chamber.

Almost immediately after the fuel charge is injected into the combustion chamber, the fuel is ignited by the hot air and starts to burn.

POWER STROKE: During the power stroke, the piston travels downward and both intake and exhaust valves are closed.

By the time the piston reaches the end of the compression stroke, the burning fuel causes a further increase in the pressure above the piston. As more fuel is added and burns, the gases get hotter and hotter and expand more and more to push the piston downward and add impetus to crankshaft rotation.

EXHAUST STROKE: During the exhaust stroke, the intake valve is closed, the exhaust valve is open, and the piston is on its upstroke.

Burned gases are forced out of the combustion chamber through the open exhaust valve port by the upward travel of the piston.

From the preceding description of the Cummins Diesel Cycle, it is apparent that the proper operation of the engine depends upon two separate functions—first compression for ignition, and, second, that fuel be measured and injected into the compressed air in the cylinder in the proper quantity and at the proper time.

The Fuel System

Cummins PT Fuel System is a completely new application of basic hydraulic principles to the diesel engine fuel system. It is a Cummins design for Cummins Diesels. The identifying letters, "PT," are an abbreviation for "pressure-time."

The principle of the PT Fuel System is based on the fact that by changing the pressure of a liquid flowing through a pipe you change the amount of liquid coming out of the open end: Increasing the pressure increases the flow or the amount of liquid delivered, and vice versa. In applying this simple principle to the diesel fuel system it was necessary to provide:

1. A fuel pump to draw fuel from the fuel tank and deliver it to individual injectors for each cylinder.
2. A means of controlling the pressure of the fuel being delivered by the fuel pump to the injectors so the individual cylinders would receive the right amount of fuel for the power required of the engine.
3. Fuel passages of the proper size and type so that the fuel will be distributed to all injectors and cylinders with equal pressure under all speed and load conditions.
4. Injectors to receive low-pressure fuel from the fuel pump and deliver it into the individual combustion chambers at the right time, in equal quantity and proper condition to burn.

The PT Fuel System consists of the fuel pump (with governor), the supply and drain lines, and the injectors. Each of these is described in detail in the paragraphs following.

Fuel Pump

The fuel pump is made up of three main units:

1. A gear pump which draws fuel from the supply tank and delivers it under pressure through the pump and supply lines to the individual injectors.
2. The pressure regulator which limits the pressure of the fuel to the injectors.
3. The governor and throttle which act inde-

pendently of the pressure regulator to control fuel pressure to the injectors.

The fuel pump is coupled to the compressor or fuel pump drive which is driven from the engine gear train. The fuel pump main shaft turns at engine crankshaft speed, and drives the gear pump, governor and tachometer shaft.

The location of these units in the fuel pump housing is indicated in Figs. 1-1 and 1-2.

GEAR PUMP: The gear pump is located at the rear of the fuel pump and it is driven by the main shaft. This unit consists of a single set of gears to pick-up and deliver fuel throughout the fuel system. From the gear pump fuel flows through the filter screen and to the pressure regulator.

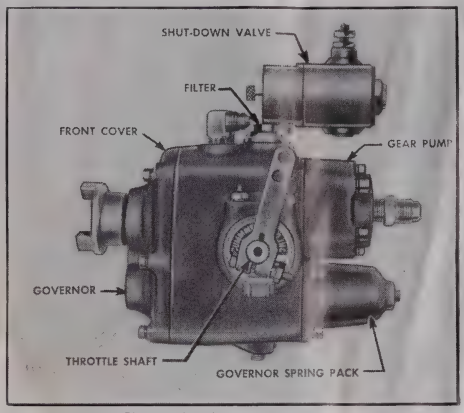

Fig. 1-1. Fuel pump units

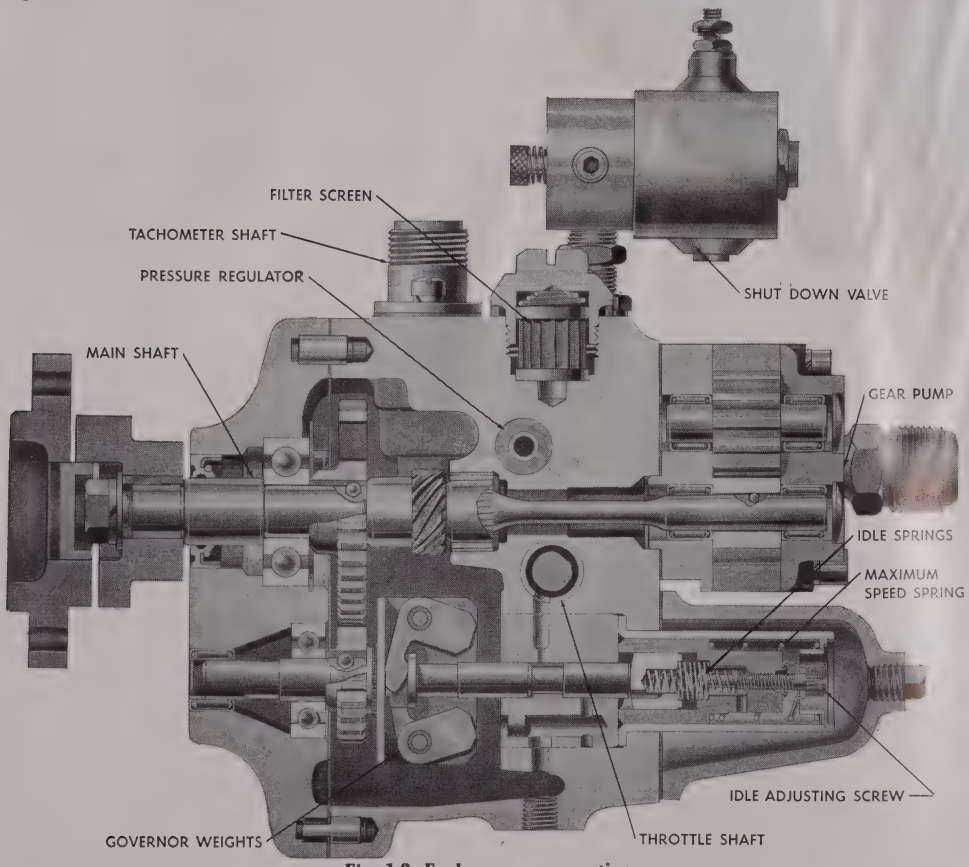

Fig. 1-2. Fuel pump cross-section

PRESSURE REGULATOR: The pressure regulator is a by-pass valve to regulate the fuel, under pressure, supplied to the injectors. By-passed fuel flows back to the suction side of the gear pump.

THROTTLE: Fuel for the engine flows past the pressure regulator to the throttle shaft. Idle fuel passes around the shaft to the idle jet in the governor. For operation above idle, fuel passes through the throttling hole in the shaft and enters the governor through the primary jets.

GOVERNOR: Mechanical governor action is provided by a system of springs and weights, and it has two functions. First: the governor maintains sufficient fuel for idling with the throttle control in idle position and second: it cuts off fuel above maximum rated rpm. The idle springs in the governor spring pack position the governor plunger so the idle fuel jet is opened enough to permit passage of fuel to maintain engine idle speed.

During operation between idle and maximum speeds, fuel flows through the governor to the injectors in accord with the engine requirements as controlled by the throttle and limited by the pressure regulator. When the engine reaches governed speed, the governor weights move the governor plunger and fuel passages to the fuel supply manifold are shut off. At the same time another passage opens and dumps the fuel to the supply manifold back into the main pump body. In this manner engine speed is controlled and limited by the governor regardless of throttle position. Fuel leaving the governor travels through the shut-down valve, inlet supply lines and on into the injectors.

Injectors

Fuel circulates through the injector at all times except during a short period following injection into the cylinder. From the inlet connection fuel flows down the inlet passage of the injector, around the injector plunger, between the body end and cup, up the drain passage to the drain connections and manifold and back to the supply tank.

As the plunger comes up the injector feed passage is opened and fuel flows through the metering orifice into the cup, at the same time fuel flows past the cup and out the drain orifice.

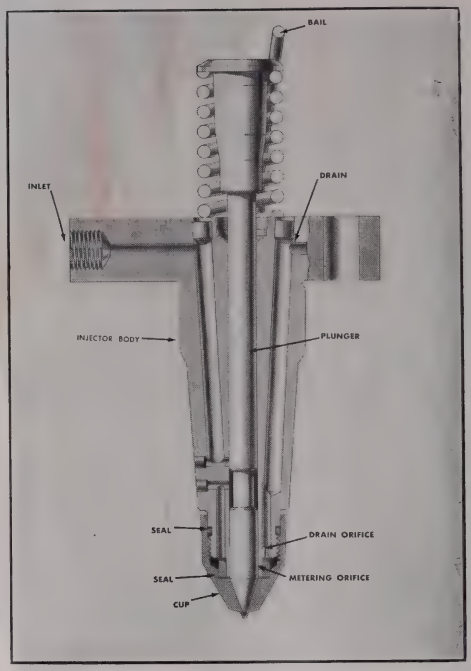

Fig. 1-3. Injector cross-section

The amount of fuel which enters the cup is controlled by the fuel pressure against the metering orifice. Fuel pressure is controlled by the fuel pump as previously described.

The plunger during injection comes down until the metering orifice is closed and the fuel in the cup is injected into the cylinder. During the period that the plunger is seated all fuel flow through that injector ceases. See Fig. 1-4.

Fuel Supply Lines And Valves

SHUT-DOWN VALVE: Manual Type: The shut-down valve is located on top of the fuel pump and it is used to shut-down the engine. This is a push-pull type valve. In other words, push in to permit fuel to flow to injectors; pull to shut off the fuel. It is important to keep this valve in the off position at all times the engine is not running.

SHUT DOWN VALVE: Electric Solenoid Type: The electric solenoid shut-down valve permits

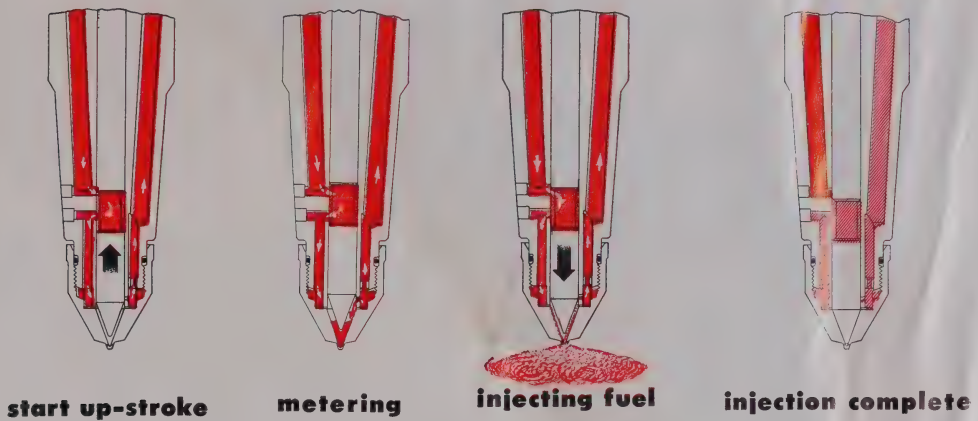

Fig. 1-4. Fuel injection cycle

the fuel to be shut off or turned on through the use of a switch key similar to that used in automotive ignition systems.

SUPPLY LINES: Fuel supply lines must be held to a specified size to insure an even pressure and supply of fuel to each injector. From the supply lines fuel enters the inlet connection to the injector.

INLET CONNECTIONS: The inlet connection connects the supply fuel manifold to the injector and contains a fine mesh screen at the large or cage end. This screen is the last protection against dirt entering the injector. There are no check valves in the inlet connection used in the PT fuel system.

DRAIN LINES: Not all the fuel entering the injector is burned in the cylinder. Part of the fuel circulates through the injector and is returned to the supply tank through the drain fittings, drain manifold and drain line. The drain lines must also be ample size to provide free drain back to fuel tank.

Valve And Injector Timing

The camshaft is driven by a gear in mesh with the crankshaft gear and it turns at half engine speed. It has three lobes for each cylinder—one for the injector plunger, one for the intake valve and one for the exhaust valve.

The injector plungers and valves are actuated by cam action through the use of tappets, rocker levers and push rods.

The Lubricating System

The working parts of Cummins J, JS and JT Engines are lubricated by force feed. The force is supplied by a gear-type lubricating pump located below the crankshaft and driven by an idler gear off the pinion gear. Oil is held in the sump in the oil pan, and is drawn from this sump by the lubricating oil pump. It is delivered to all working parts of the engine through lubricating oil lines and the oil header, the latter being drilled the full length of the block.

Various drillings through the block, cylinder head, crankshaft, connecting rods and rocker levers complete the oil circulating passages.

Lubricating oil is forced from the crankshaft to lubricate the main and connecting rod bearings. Lubricating oil pressure is controlled by a regulator in the oil strainer head.

Filters, strainers and screens are provided throughout the lubricating system for proper cleaning of the lubricating oil.

The air compressor, supercharger and water-pump-drive all receive pressure lubrication from the engine oil supply.

The injector plunger in the injector and the working parts in the fuel pump are lubricated by fuel oil. The fuel oil used for lubrication of the injector plunger is returned to the fuel tank through drain lines.

The schematic diagram, "Lubricating Oil Flow," shows direction of oil flow and the various units provided to clean and cool hot oil, and maintain a constant pressure of 30/50 psi in the header at governed engine rpm.

By-pass valves are provided in the strainer and cooler as insurance against interruption of oil flow by dirty or clogged strainer and cooler elements.

The Cooling System

Water is circulated by a centrifugal-type water pump mounted to the rear of, and driven by, the supercharger.

The water circulates around each of the wet-type cylinder liners, through the cylinder head and around the injector sleeves in the cylinder head. The injector sleeves, into which the injectors are mounted, are made of copper for fast dissipation of heat. The thermostat housing and water by-pass contain three thermostats to control the operating temperature of the engine.

JS marine engines (also J and JT engines) are equipped with a single large thermostat to control the operating temperature of the engine.

The engine cooling solution is cooled by the radiator, or on marine engines, by the heat exchanger. Where heat exchangers are used, a sea water pump is mounted on the engine and circulates sea water inside the tubes of the heat exchanger. The engine's fresh water supply circulates around these tubes.

Engine Unit Replacements

The design of Cummins engines makes it possible to replace worn units with the new or rebuilt units in a few hours so you can get the engine back on the job.

Cummins dealers are prepared to rebuild your engine or engine units, or to help you by supplying special up-to-date instructions for rebuilding in your shop.

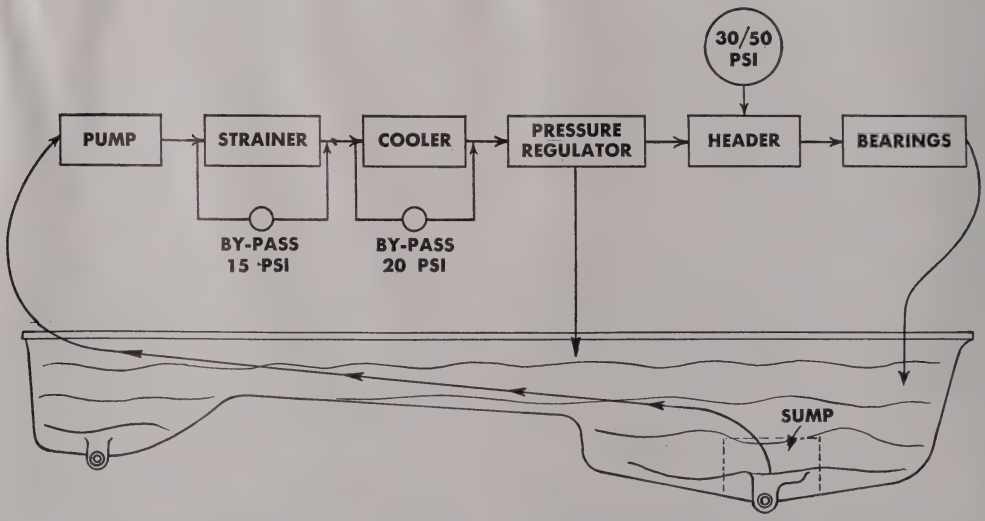

Fig. 1-5. Lubricating Oil Flow—Schematic Diagram

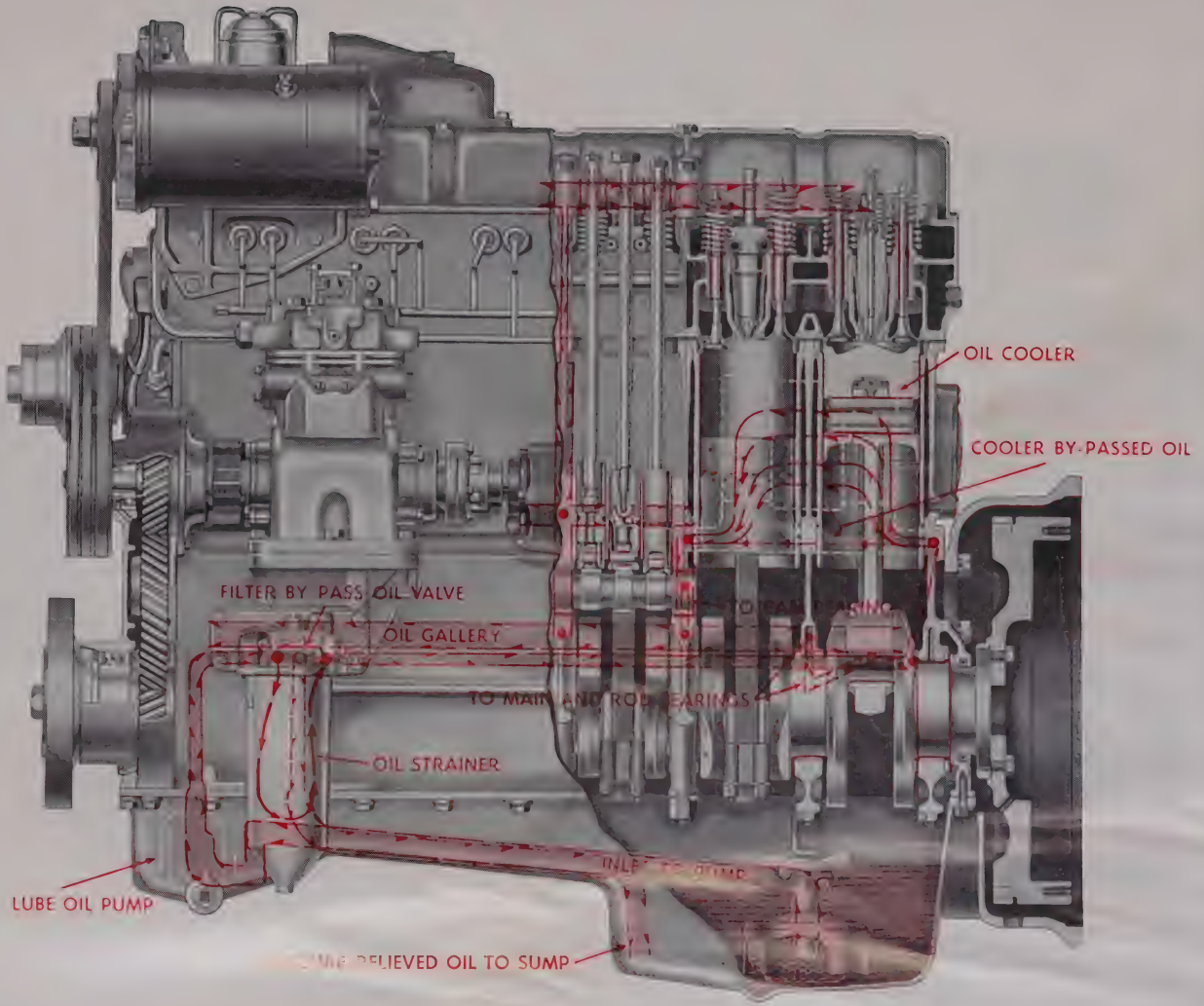

Fig. 1-6. Cross section of JS engine, side view

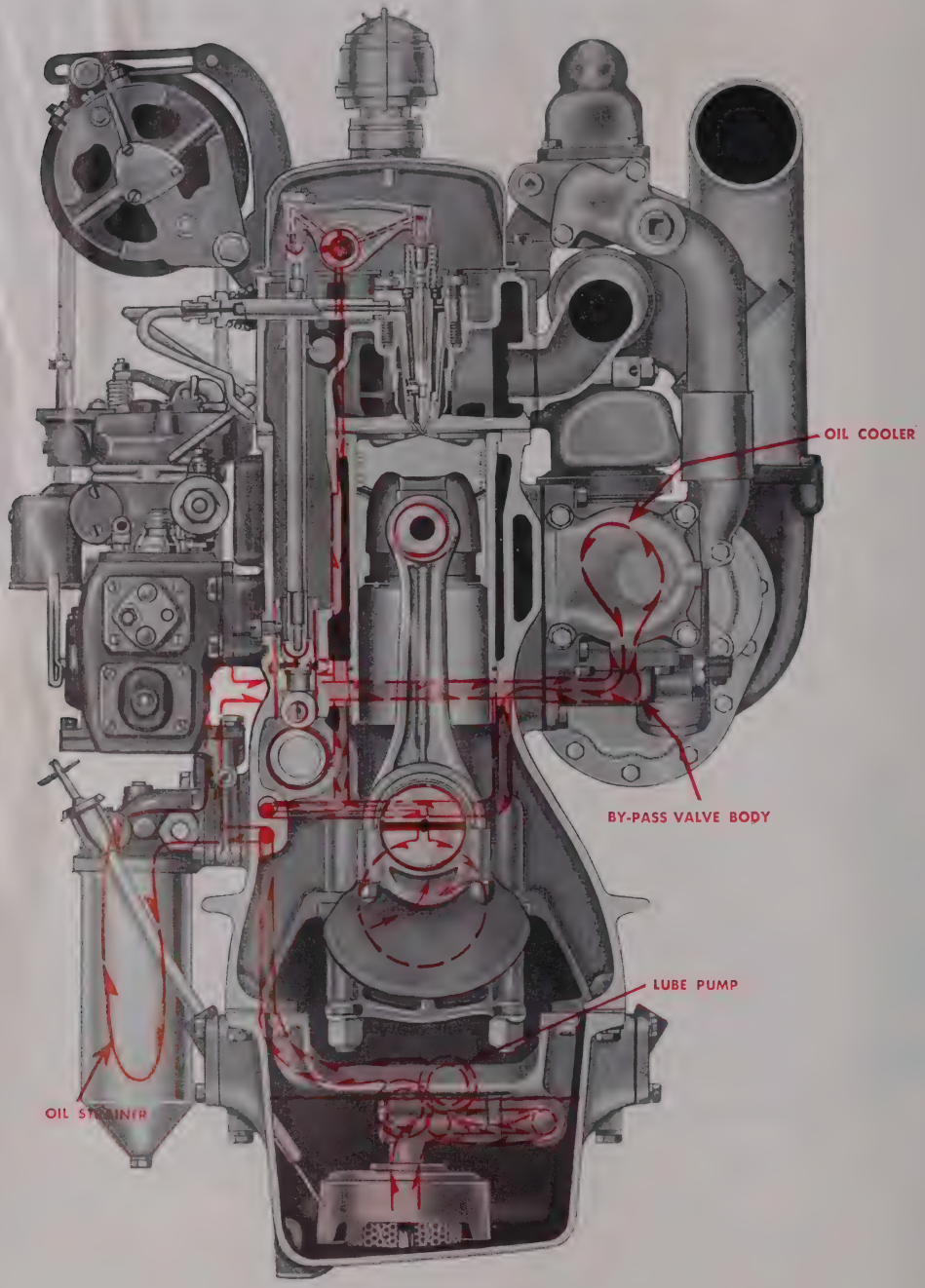

Fig. 1-7. Cross section of JS engine, end view

SECTION II

Operating Instructions

The operator of the engine assumes the responsibility of engine care while it is being worked. This is an important job and one that will determine to a large degree the extent of profit from the operation.

There are comparatively few rules which the operator must observe to get the best service from the Cummins Diesel. However, if any of these rules are broken, a penalty is certain to follow. The penalty may be in lack of work accomplished because of lowered engine efficiency or it may be in down time and costly repair bills resulting from premature engine failure.

New Engine Break-In

The way you operate your new engine during the first 50 to 100 hours' service will have an important effect on the life of the engine and its parts. Its moving parts are closely fitted for long service, and even though all Cummins engines are run on a dynamometer for several hours before they leave the factory, an additional period may be required before uniform oil films are established between all mating parts.

During the first 50 to 100 hours' service:

1. Operate most of the time at one-half to three-quarters throttle. Do not operate at maximum horsepower for more than five or ten minutes at a time.
2. Do not idle the engine for long periods because this will cause cylinder walls to glaze before the piston rings seat properly and the engine will continue to use too much lubricating oil.
3. Keep a close watch on your instruments. Back off on throttle if oil temperature reaches 200° F. or if water temperature exceeds 185° F.
4. Drive in a gear low enough so you can accelerate under any condition to prevent lugging your engine.

Pre-Starting Checks

Check the Lubricating Oil Supply:

1. A dip stick oil gauge is located on the side of the engine. The dip stick supplied with the engine has a high "H" and a low "L" level mark to indicate lubricating oil supply. The dip stick must be kept with the oil pan, or engine, with which it was originally supplied. Cummins oil pans differ in capacity with different type installations and oil pan parts numbers.

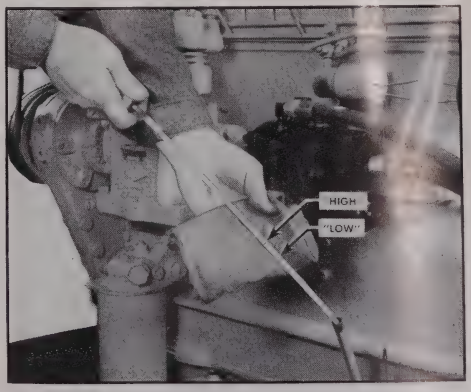

Fig. 2-1. Checking lubricating oil supply

2. Keep oil level as near the high level mark as possible. Never operate the engine with oil level below the low level mark.

Check Engine Coolant Supply:

1. Remove the radiator cap and check the engine coolant supply. Add coolant as needed to completely fill the system.

2. There are several recognized methods of protecting engine cooling systems from rust and corrosion. These methods are described in Section III, Page 3-25.

Check Injector Plunger and Valve Adjustments:

Make sure that injector plungers and valves are adjusted in accordance with instructions in the MAINTENANCE SECTION.

Check Fuel Supply and Connections:

Make sure there is an adequate supply of good clean No. 2 diesel fuel. See "Fuel Specifications," Page 3-23.

Starting The Engine

There is no mystery about starting a Cummins Diesel Engine. Starting requires:

An Air Supply to The Combustion Chambers
A Fuel Supply to The Combustion Chambers
Compression of the Air for Ignition

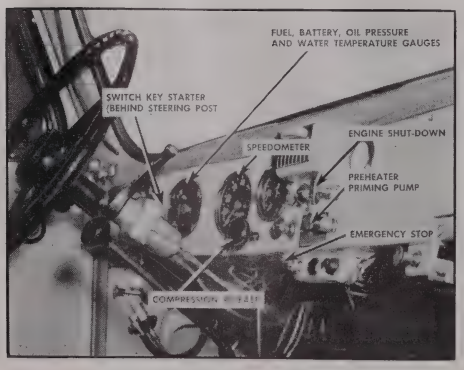

Fig. 2-2. Instrument panel

Normal Starting Procedure:

1. Set throttle for idle speed.
2. Release the clutch.
3. If you have a manual fuel shut-off valve, open it.
4. Pull the compression release.
5. Press the starter button or turn switch-key to "start" position.

   A manual over-ride button is provided on the forward end of the electric shut-down valve above the fuel pump. It allows the valve to be opened in case of electric power failure. To use, push in button and lock by turning to right.
6. After three or four seconds of cranking close the compression release and continue to crank until the engine fires.

NOTE: Do not crank engine for more than 30 seconds continuously or you may burn out the cranking motor. If engine does not fire within the first 30 seconds wait two to five minutes before re-cranking.

Use the Preheater for Cold Weather Starting:

As an aid in starting the engine when the ambient temperature is 50° F. or below, an intake air preheater arrangement is supplied as standard equipment on all JS and JT engines. This equipment consists of a hand priming pump to pump fuel into the intake manifold, a glow plug electrically heated by the battery, and a switch to turn on the glow plug when fuel is pumped into the intake manifold. The fuel burns in the intake manifold and heats the intake air.

To use the preheater for cold starting follow this starting procedure:

1. Set throttle in idle position.
2. Give one or two strokes to preheater priming pump—just enough to prime it—then stop pumping immediately. Over priming will wet glow plug and delay ignition in preheater.
3. Engage glow plug manual switch and keep it engaged for 20 seconds.
4. Crank engine while operating preheater priming pump to maintain 80 to 100 psi fuel pressure. Red light must be on indicating that current is flowing to glow plug.

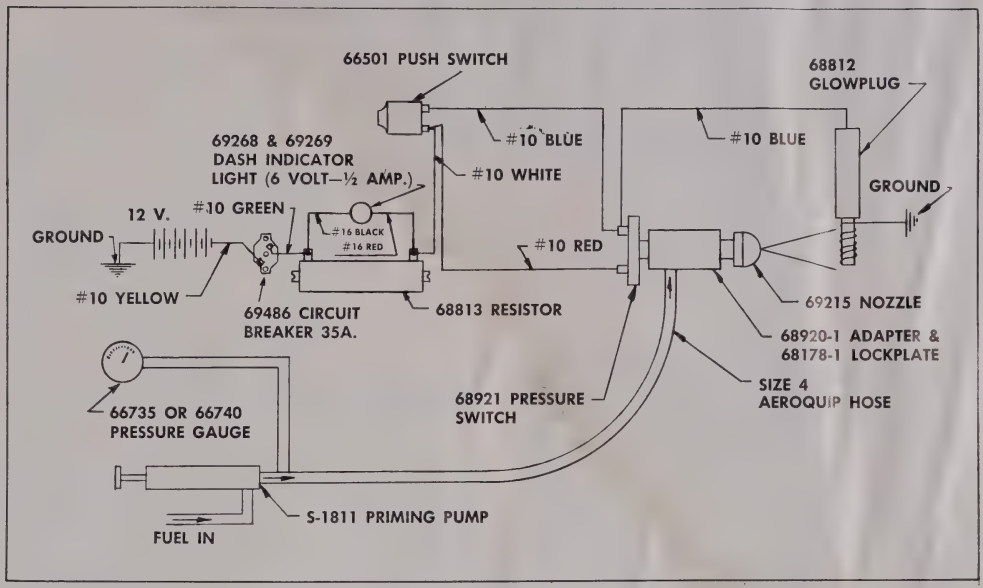

Fig. 2-3. Preheater wiring diagram

5. After engine starts, maintain only sufficient fuel pressure to keep the engine idling smoothly. Pressure may vary between 40 and 100 psi.
6. When engine has warmed up until it does not falter between preheater pump strokes, stop pumping and lock pump.

When the preheater is not in use, the dash indicator light should be off, indicating that no current is flowing to the glow plug.

DO NOT USE PREHEATER WHEN ENGINE IS PULLING LOAD. THE PREHEATER BURNS INCOMING AIR, AND MAY RESULT IN DAMAGE TO THE ENGINE.

FAILURE TO START: 1. If the engine gives no indication of starting during the first three full strokes of the preheater pump, check the intake manifold for heat. If there is no heat, check electric wiring. If wiring is all right, remove ⅛" pipe plug from manifold near glow plug and check flame while a helper performs the preceding steps 2, 3 and 4.

2. If no flame is observed, close glow plug manual switch 15 seconds and observe glow plug through ⅛" pipe plug hole. The glow plug should be white hot; if not, connect glow plug to a six-volt source and check amperage which should be 30 (minimum). If glow plug is all right, check manual switch and resistor and replace if necessary.

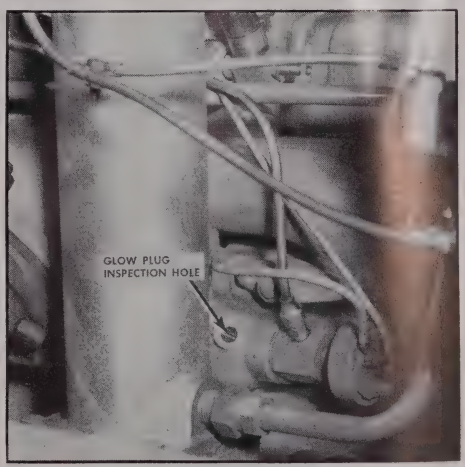

Fig. 2-4. Glow plug inspection hole

3. If dash indicator light is on when manual switch is closed but does not stay on at pressures above 30 psi, the pressure switch is bad and should be replaced.

4. If glow plug is white-hot, and no flame is observed, remove the fuel nozzle and clean.

Engine Warm Up

Warm Up Engine Before Applying Load:

When the engine is started, it takes a while to get the lubricating oil film re-established between shafts and bearings and between pistons and liners. The most favorable clearances between moving parts are obtained only after all engine parts reach normal operating temperature.

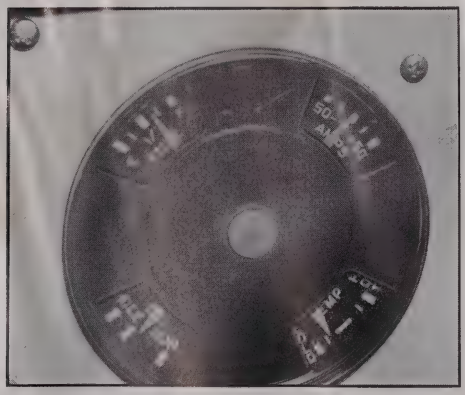

Fig. 2-5. Minimum operating temperature

Avoid seizing pistons in liners and running dry shafts in dry bearings by bringing the engine up to operating speed gradually as it warms up. Allow the engine to run at 800 to 1000 rpm long enough to bring water temperature to at least 130° F. before engaging the load. During this time make all the necessary outside checks; load distribution, brakes, fifth wheel, air and electric couplings, tires, etc. During the next 10 to 15 minutes, or until water temperature reaches 160°/165° F. operate at partial load and at not more than 1800 rpm.

Apply Load Gradually:

Always start the load moving in a gear low enough so you can accelerate to governed rpm, then catch the next gear as you decelerate. Do not skip gears or lug the engine while you are getting up to cruising speed.

Shock loads take their toll of tires and transmissions as well as being hard on the engine. Apply load gradually.

Cruising Speeds

Operate at Reduced RPM for Cruising or Continuous-Duty:

The governed full-load rpm of the J engine is 2200 rpm; the JS and JT 2500 rpm. This maximum-speed rating is for intermittent duty only, and it must be reduced for continuous duty.

When you are operating a truck on a level highway, or cruising, hold engine rpm at approximately 85 percent of governed rpm. For the J engine this will be 1850 to 1900 rpm, and for JS and JT engines 2100 to 2150 rpm. This will give you adequate power for cruising and economical fuel mileage.

Engine governors are set for reduced rpm for continuous-duty operation.

Fig. 2-6. Cruise at 85% governed rpm

The Instrument Panel

Drive By Your Instruments:

The instruments in a truck are just as important to the driver as the panel board is to an air pilot even though they are fewer in number. The best drivers learn to use them and to depend on them. Be an instrument driver.

It makes no difference whether your engine is in a truck, in a boat or on some other type operation; you need to use the panel board instruments. The instruments tell you at all times what you need to do to get the most satisfactory service from your engine.

Use the Tachometer to Avoid Lugging:

Whenever you operate an engine under full-throttle and you can not reach or maintain governed rpm you are lugging the engine.

Lugging is bad driving practice because under lugging conditions maximum pressures are exerted against the pistons, rings, rods, crankshaft and bearings. Fuel consumption increases, exhaust is more likely to be smoky and high exhaust temperatures tend to burn valves and exhaust manifold when you lug your engine.

The tachometer also shows you how much horsepower you have available. Whenever your engine speed drops, you lose horsepower.

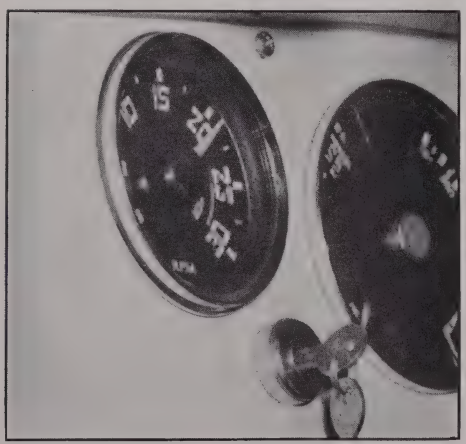

Fig. 2-7. Tachometer

It is easy to avoid lugging. All you have to do to get maximum horsepower and get out of the lugging condition is shift to a lower gear, then with full-throttle your engine will rev up to governed rpm.

The Oil Temperature Gauge Indicates Best Driving Range:

Your oil temperature gauge normally should read between 180° F. and 200° F. for best lubrication. Under full-load conditions, such as pulling a heavy load uphill, a temperature of 225° F. for a short period is not to be considered cause for alarm.

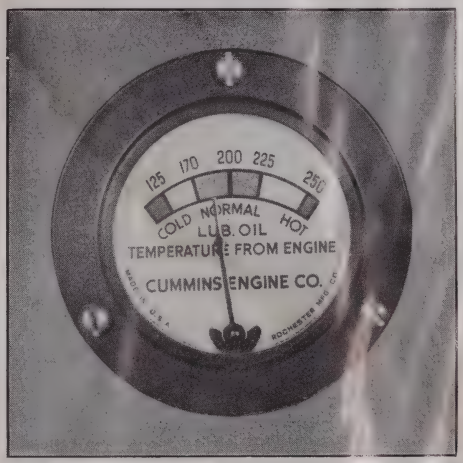

Fig. 2-8. Oil temperature gauge

Any sudden increase in oil temperature which is not caused by load increase is a warning of possible mechanical failure, and it should be investigated at once.

During warm-up period apply load gradually until oil temperature reaches 170° F. While oil is cold it does not do a good job of lubricating. Also, if you operate continuously with oil temperatures much below 170° F. you are likely to have crankcase dilution and acids in the lubricating oil which will accelerate wear tremendously.

Keep Water Temperature Between 165°F. and 185°F.:

A water temperature of 165° F. to 185° F. is the best assurance that cylinder liners are heated

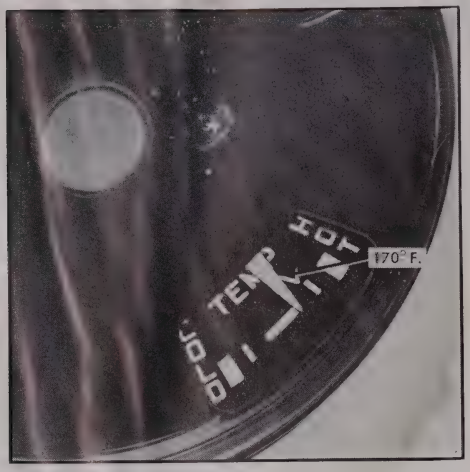

Fig. 2-9. Water temperature

to the proper temperature to support good combustion, and that working parts of the engine have expanded evenly for the most favorable oil clearances.

Engines should be warmed up slowly before applying full load so that pistons will not expand too fast for the cylinder liners. Most cases of piston and liner scoring start from throwing full load on a cold engine.

When water temperature is too low the cylinder walls retard heating of air during the compression stroke and delay ignition of fuel. This causes dilution of lubricating oil, fuel knocks, incomplete combustion exhaust smoke, and high fuel consumption.

Keep thermostats in the engine summer and winter, avoid long periods of idling, and do whatever else is required to keep water temperatures up to a minimum of 165° F. If necessary in cold weather, use radiator shutters or cover a part of the radiator to prevent over cooling.

Of course there is also the problem of overheating but that requires mechanical correction. It may be caused by loose water pump belts, a clogged cooling system, or insufficient radiator capacity. Report cases of overheating to the maintenance department for correction.

Keep An Eye On Your Oil Pressure Gauge:

First of all your oil pressure gauge shows whether you have a supply of lube oil. A good operator will note loss of oil pressure immediately and shut down his engine before he loses his bearings.

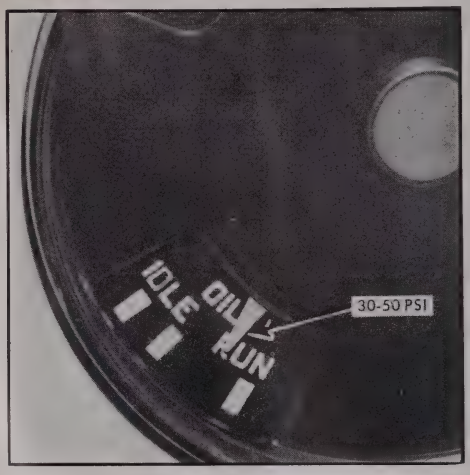

Fig. 2-10. Oil pressure

The oil pressure gauge also indicates the condition of lubricating oil. If pressure drops between oil changes it may be due to dilution, to a clogged suction line, or to an internal oil leak. Always investigate and determine cause of decreased oil pressure.

A Rear View Mirror Pointed At Exhaust Stack Is a Valuable Instrument:

One of the most valuable instruments is a rear view mirror that lets the driver observe the exhaust smoke. A smoky exhaust may be due to a poor grade of fuel or mechanical conditions but more often smoke is a sign of lugging.

If your exhaust is smoky, change to a lower gear.

Fig. 2-11. Watch your exhaust

Meeting Maximum Horsepower Requirements

Maximum horsepower is attained only at maximum, or governed, engine rpm. Whenever you pull down engine rpm by overload you start losing horsepower, and you continue to lose it as long as the engine continues to lose rpm. When you need full horsepower operate your engine against the governor. This rule applies to any kind of application.

When You Approach a Hill Shift to a Lower Gear and Operate Against the Governor:

When you approach a hill you know that you will require more horsepower than you have been using on level highway. In order to avoid lugging shift to the next lower gear as you go into the grade and accelerate to governed rpm. This will give you additional horsepower at about the same road speed.

As an example: Suppose you have a JS engine and are cruising at 50 mph with tachometer showing 2000 rpm. You shift to next lower gear and increase engine rpm to 2500. If this gives you 48 mph road speed you have immediately

Fig. 2-12. Change gears for hill

"hitched on" an additional 30 horsepower to carry you well up the grade without any appreciable loss in road speed, and you are not lugging your engine.

Shift to a Lower Gear When the Load Pulls Down Engine RPM as Much as 10%:

Operating at full-throttle the engine will maintain full governed rpm until the load requirement exceeds the available horsepower. Then, the engine loses rpm and horsepower and almost immediately you are in a lugging condition.

The solution is to shift to the next lower gear and trade road speed for more torque at the

Fig. 2-13. Watch engine rpm

wheels. Shifting from gears which give you 48 mph to 36 mph gives you 33 1/3 per cent more power at the wheels.

Never allow the engine rpm to drop more than 10%—from 2500 on JS to 2250—before you start shifting.

This practice will always give you maximum horsepower where you need it and you will not damage the engine by lugging.

On a long grade—particularly during hot weather—watch your oil temperature gauge closely. If oil temperature reaches 225° F. reduce load by shifting again to next lower gear.

The practice of shifting gears—next to safety observance—is the most important phase of good driving.

High Altitude Operation

Air density, or the amount of air in a given volume decreases with altitude. Ordinarily, this decrease is about 3% for each 1000 feet of altitude. The engine is more likely to smoke at high altitude and it can not deliver as much power because there is not enough air available to burn, in the time available, all the fuel being metered by a fuel pump set for sea level operation.

The supercharger on the JS engine or the turbocharger on the JT increases the amount of air for each cylinder under any conditions of altitude. But, whether an engine is natural-aspirated or supercharged, it can not deliver as much power at high altitude as at sea level.

Fig. 2-14. Thin air at high altitude

Operate in Lower Gears at High Altitude:

Avoid smoky exhaust and engine lugging by operating in a lower gear at high altitude. In general, the same rules for use of gears applies to up-hill and high-altitude operation.

Down-Hill Operation

If the engine is used as a brake when going down hill, it is being pushed by the vehicle and the governor has no control over the engine speed. Overspeeding under these conditions is just as bad as if the governor were removed.

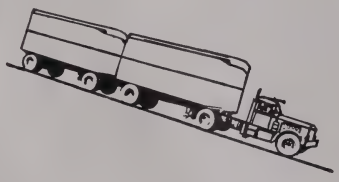

Fig. 2-15. Down-hill operation

Use Brakes as Needed to Prevent Excessive Engine Speeds:

Never, under any circumstances, operate a vehicle without brakes and never allow the vehicle to push the engines beyond its maximum rated rpm.

Engine Shut-Down

Let the Engine Idle a Few Minutes Before Shutting It Down:

If a hot engine is shut off immediately without giving it a chance to cool gradually, the heat can not escape from bearings, pistons and liners because lubricating oil circulation and water circulation stops when the engine stops.

Do Not Idle the Engine for Excessively Long Periods:

Long periods of idling with resultant low operating temperatures may result in gumming of rings, clogged injector spray holes and parts failures due to lack of lubrication.

Turn Switch Key to "Off" Position to Shut Down the Engine:

The engine can be shut down completely by turning off the switch key on installations equipped with an electric solenoid valve, or by pulling out the manual shut-down lever.

Turning off switch key which controls electric shut-down valve always stops engine unless over-ride button on shut-down valve has been locked in open position. Refer to "Normal Starting Procedures" Page 2-2. Valve can not be re-opened by switch key until after engine comes to complete stop.

Never leave switch key or over-ride button in valve-open or run position when engine is not running. With overhead tanks this would allow fuel to drain into cylinders causing a hydraulic lock.

Do Not Use the Compression Release Lever to Stop the Engine:

All Cummins engines are equipped with a compression release lever. Pulling this lever lifts the intake valve push rods and opens the intake valves. The push rods will be pulled from their sockets, and extensive wear on the balls and sockets will result from using the compression release to stop the engine.

The compression release lever is to be used as an aid in cranking, before starting or while making injector and valve adjustments and not to stop the engine.

Stop the Engine Immediately If Any Parts Fail:

Practically all failures give some warning to the Operator before the parts "let go" and ruin the engine. Most engines are saved because alert operators heed warning signs (sudden drop in oil pressure, unusual noises, etc.) and immediately shut down the engine. A delay of ten seconds, after a bearing failure causes a knock, may result in a ruined crankshaft. Five seconds delay may be enough to cause a block to be perforated by a broken connecting rod.

Never try to make the next trip or another load after the engine warns you that something is wrong. It does not pay!

Cold Weather Protection

ANTI-FREEZES: Methanol, denatured alcohol, or permanent type non-corrosive antifreezes should be used for cold weather operations.

Soluble oil can not be used successfully with antifreeze. For cold weather operation, we recommend permanent-type (ethylene-glycol) antifreeze with rust inhibitor.

DRAINING CYLINDER BLOCK: To assure complete draining of the cylinder block it will be necessary to remove drain plugs. Fig. 2-16.

Failure to remove any one of these plugs may cause serious damage in freezing weather. If water-cooled manifold is used, it will also be necessary to remove the drain plug from the manifold for complete drain. On engines equipped with an oil cooler, remove the ¼" pipe plug below the oil cooler outlet.

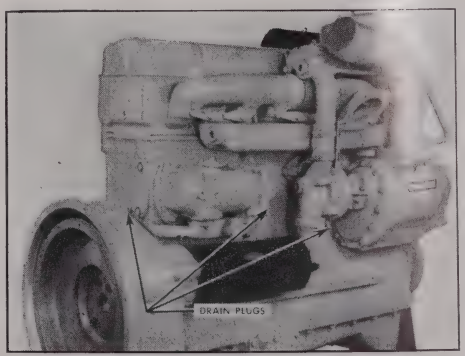

Fig. 2-16. Plugs for draining cylinder block

Operator's Daily Report

Make a Daily Report Of Engine Operation to the Maintenance Department:

The engine must be maintained in top mechanical condition if the operator is to get the most satisfaction from its use. Engine adjustments, etc., are the work of the maintenance department. However, the maintenance department needs daily running reports from the operator to make necessary adjustments in the time allotted between runs and to make provisions for more extensive maintenance work as the reports indicate the necessity.

Comparison and intelligent interpretations of the day by day rep[illegible]ill make it possible to eliminate practic[illegible] all road failures and emergency repairs

OPERATOR'S DAILY (or) TRIP REPORT
Truck or engine number_____Date_____
Mileage or hours at start of run_____
Finish_____
Lubricating Oil
Pressure at idling: Minimum_____psi
Pressure at governed speed_____psi
No. quarts of oil added_____
Brand_____Weight_____
Fuel Oil
Minimum pressure at idling_____psi
Pressure at governed speed_____psi
No. gallons added to tank_____
Brand_____
Water Temperatures
Maximum_____° F.
Minimum after warm-up_____° F.
Smoke Condition: Good ☐ Bad ☐
Report any unusual engine condition needing inspection or maintenance_____
_____
_____
OPERATOR

SECTION III

Maintenance

All moving parts of an engine—and other parts in contact with the moving parts—wear as the engine is used. Wear eventually progresses to the point that some parts must be replaced. Wear can not be prevented but it can be retarded by good operation and good maintenance. Just as the Operator is responsible for the care of the engine while it is being run, the Maintenance Mechanic is responsible for keeping the engine in top mechanical condition.

A good maintenance schedule is one that keeps the engine in first class mechanical condition and anticipates engine part failures before they occur. If a part is allowed to fail, it is very likely that failure will result in damage to other related engine parts. Emergency failures of this kind are expensive in both time and money.

The maintenance program must be periodic and progressive. Unless a definite periodic program is practiced, maintenance becomes a haphazard procedure and it fails of its purpose. The program must be progressive so that the operations will be performed in proper sequence and when they are needed.

Maintenance operations are concerned with cleanliness, lubrication, fuel, air, cooling, adjustments, and units or parts replacements.

Fuel Consumption In Relation To The Maintenance Schedule

The maintenance schedule should be based on fuel consumption.

A satisfactory periodic maintenance schedule can not be established on the basis of hours of industrial operation or miles of truck operation unless all the engines are working under the same conditions. Cummins Diesels are used in widely varied operations, both as to the type of operation and the rate of work. Some engines in industrial applications work on a 15% to 20% average load factor, and others on a 40% to 60% average load factor. Some trucks haul 30,000 pounds gross weight; others 55,000 pounds. Some travel at 20 miles per hour; others at 50 miles an hour.

Obviously, other things being equal, the amount of wear should be proportional to the amount of work. Work is measured in horsepower hours and is obtainable from the fuel that is burned. Therefore, it is evident that a maintenance schedule should be established on the basis of gallons of fuel consumed. The maintenance schedules in this section are based on fuel consumption.

All that remains for any operator to do is determine average fuel consumption for his operation and change these periods to hourly or mileage intervals. For instance, if the trucks in one fleet average seven miles per gallon of fuel, the "500 gallons of fuel" would be changed to "3500 miles"; or, if an off-highway operator finds his units are using an average of four gallons of fuel per hour, the "500 gallons of fuel" would be changed to 125 hours. Any type of operation can be converted in this same manner.

Differences in operating conditions do not require any special conversion factor because the proper auxiliary equipment should be provided in the original installation to compensate for unusual operating conditions such as dust, extreme low or high ambient temperatures, etc.

Maintenance Schedule

CUMMINS J, JS AND JT ENGINES

	"A"	"B"	"C"	"D"	"E"	"F"
	Daily Or Trip Oper.	**Each 500 Gallons** (FUEL CONSUMED)	**Each 1000 Gallons** (FUEL CONSUMED)	**Each 2000 Gallons** (FUEL CONSUMED)	**Each 4000 Gallons** (FUEL CONSUMED)	**Each 16000 Gallons** (FUEL CONSUMED)
	☐ Investigate Drivers Report	☐ Repeat "A" Operations	☐ Repeat A and B Operations	☐ Repeat A, B and C Operations	☐ Repeat A, B, C, D Operations	☐ In Frame Overhaul
FUEL SYSTEM	☐ Fill Fuel Tanks ☐ Check Lines for Leaks	☐ Tighten Connections ☐ Drain Sediment (Filter and Tanks)	☐ Clean Inlet Conn. Screens ☐ Clean Pump Screen	☐ Change Filter Element	☐ Clean Injectors	☐ Rebuild Injectors and Connections ☐ Rebuild Pump
LUBRICATION SYSTEM	☐ Check Crankcase Oil Level ☐ Check Lines for Leaks	☐ Change Crankcase Oil ☐ Tighten Connections ☐ Clean Strainer Element ☐ Record Oil Pressure	☐ Change By-Pass Filter Element	☐ Flush Crankcase, if Needed		☐ Clean Oil Pan ☐ Pressure Lubricate Oil Lines ☐ Rebuild Pump—If Necessary ☐ Clean Oil Cooler
COOLING SYSTEM	☐ Fill Radiator Note: Water should contain 3% to 4% Soluble Oil	☐ Tighten Connections	☐ Check Soluble Oil Solution ☐ Check and Adjust Belts	☐ Check Thermal Controls ☐ Tighten Drive Pulleys on Shafts	☐ Drain and Flush Radiator ☐ Grease Water Pump and Fan Hub	☐ Rebuild Water Pump
INTAKE-EXHAUST SYSTEMS		☐ Change Oil in Air Cleaner and Air Breather ☐ Tighten Connections	☐ Clean Air Cleaner Tray ☐ Check Air Cleaner Connections, Hose and Clamps ☐ Clean Air Breather	☐ Inspect Supercharger or Turbocharger for Oil Leaks	☐ Check Air Inlet Restriction. Clean Air Cleaner Screens and Body if Restriction Exceeds 18 Inches Water	☐ Rebuild Supercharger ☐ Clean Intake System ☐ Clean Exhaust System ☐ Pressure Check Air Cleaning System for Leaks ☐ Check Exhaust Back Pressure
AIR and ELECTRIC EQUIPMENT			☐ Lubricate Starter and Generator	☐ Inspect Wiring. Tighten and Clean Connections ☐ Blow Dirt from Starter and Generator ☐ Inspect Brushes, Commutators ☐ Tighten Air Connections	☐ Grease Starter Drive	☐ Inspect Electric Equipment and Rebuild, as Needed ☐ Rebuild Compressor
OTHER ENGINE UNITS		☐ Retighten Cylinder Head Stud Nuts on New or Rebuilt Engine at First Oil Change Only		☐ Steam Clean Engine ☐ Adjust Valves and Injectors ☐ Tighten All Bolts and Nuts ☐ Check Oil Loss at Rocker Levers ☐ Check for Engine Blow-by	☐ Check Crankshaft End Clearance with Indicator Gauge	Inspect; Replace as Needed ☐ Con. Rod Bearings ☐ Main Bearings ☐ Liners ☐ Pistons ☐ Drive Unit Bearings ☐ Install New Piston Rings Install New or Rebuilt ☐ Cylinder Heads ☐ Rocker Lever Assembly ☐ Cam Follower Assembly ☐ Road Test Engine

AFTER SECOND "A to F" CYCLE, REMOVE ENGINE FROM CHASSIS AND REBUILD COMPLETELY

ENGINE SERIAL NO._____ DATE _____

MILEAGE OR HOUR RECORD_____ HOURS SPENT ON THIS CHECK_____

OPERATION PERFORMED_____ MECHANIC'S SIGNATURE_____

MATERIAL ORDER NO._____ (SEE REVERSE SIDE OF SHEET FOR REMARKS)

Form No. 6338

SCHEDULED MAINTENANCE OPERATIONS

All protective maintenance operations must be scheduled—and performed according to the schedule—if the program is to be successful. Management must provide the coordination necessary between departments to insure that units will be available on schedule to the maintenance department.

The proper forms and directions for use must be provided, and accurate records must be kept. The forms and the system need not be elaborate but they must be complete enough to insure adequate control. The records will prove the efficiency of the program.

The scheduled operations described on succeeding pages are set up on the basis of fuel consumption as explained on Page 3-1.

Maintenance Schedule Forms

The "Maintenance Schedule" on Page 3-2, lists all of the maintenance checks to be performed on the engine. The chart can be used as a check-off sheet to aid in the performance of the various operations listed. The chart is not expensive to reproduce, and you have the permission of Cummins Engine Company to reproduce as many copies of this form as you may require.

The Maintenance Check Forms, Figs. 3-1, 3-3, 3-5, 3-9, 3-16, 3-17 and 3-18, lists each maintenance check separately, and the operations to be performed at each check are tabulated in a logical order of sequence.

The "Engine Maintenance Operations Summary," Fig. 3-19, can be used to keep a record of all the maintenance checks performed during the complete service period of 32,000 gallons fuel consumed.

"A" CHECK FORM—PROTECTIVE MAINTENANCE OPERATIONS

Perform Each Day

Time In_____ Date_____

Unit No._____ Time Out_____ Shift_____

- ☐ Check lubricating oil level and add oil, of same brand and weight, as needed.
- ☐ Fill fuel tanks.
- ☐ Add engine coolant, if needed, from prepared mixture containing rust inhibitor.
- ☐ Determine and correct causes of reported:
  - Low lubricating oil pressure
  - Low fuel pressure
  - Abnormal water or oil temperature
  - Unusual engine noise
  - Poor combustion, if evidenced by excessive smoke.
- ☐ Visually check all fuel and lubricating oil connections for leaks. Correct as needed.

Notes

_____

Mechanic _____

Inspector _____

Use your Instruction Manual

Fig. 3-1. Maintenance operations to be performed each day

"A" Daily Maintenance Operations

These maintenance operations should be performed at the end of each day or work shift.

CHECK LUBRICATING OIL LEVEL: 1. Keep oil level as near the high level mark as possible. Never operate an engine with oil level below low level mark.

2. Different brands or different grades of lubricating oil should never be mixed in the engine. It is best to choose the best oil available and continue to use that brand in the proper grade or weight consistent with weather conditions and engine wear.

FILL FUEL TANKS: Fuel tanks should never be allowed to run dry because the fuel lines will then contain air and it will be necessary to expel all air by priming operations. Do not miss an opportunity to filter or strain the fuel before or while putting it in the tank.

See "Fuel Oil Specifications," Page 3-23.

FILL COOLING SYSTEM: Add engine coolant, if needed, from a prepared mixture containing rust inhibitor. See Page 3-25.

CHECK OPERATOR'S REPORT: Normally, and if scheduled maintenance operations are well done, the operator will not find it necessary to criticize engine performance.

Investigate and correct reported cases of:

1. Low lubricating oil pressure.
2. Low fuel pressures.
3. Abnormal water or oil temperature.
4. Unusual engine noise.
5. Excessive smoke.

CHECK OIL OR FUEL LEAKS: After the rest of the daily operations have been performed, start the engine; allow the operating temperature to come to normal and then bring up engine speed to maximum governed speed. Check all fuel and lubricating oil lines for leaks and correct as needed.

"B" Maintenance Operations Each 500 Gallons Fuel Consumption

These maintenance operations should be performed at 500 fuel gallon intervals.

Operations performed daily should also be performed in this maintenance check as noted. These repeat operations are indicated by reference letters on the check form.

CHANGE LUBRICATING OIL: The kind of oil used, the efficiency of the filtering system and the condition of the engine must be considered in determining whether the oil needs changing more often.

Many owners have found it pays to have oil analyzed for dilution, sludge, etc., as the condition of the drained oil is a good record of past engine performance.

After draining, fill crankcase to the "H" high mark on the bayonet gauge with same brand and grade lubricating oil as removed. See Page 3-21 "Lubricating Oil Specifications."

Add additional oil to compensate for that removed from the dirty strainer case.

CLEAN LUBRICATING OIL STRAINER ELEMENT: 1. Loosen the capscrew at the bottom of the strainer case and lower the case to remove the case and strainer assembly. (Fig. 3-2).

Fig. 3-2. Remove strainer element

"B" CHECK FORM—PROTECTIVE MAINTENANCE OPERATIONS

——Perform Each 500 Gallons Fuel Consumed, or Equivalent Mileage or Hour Interval——

Time In_____Date_____

Unit No._____ Time Out_____Shift_____

- ☐ Change lubricating oil.
- ☐ Clean the lubricating oil strainer element. Inspect the element for bearing metal.
- ☐ Drain sediment from fuel filter case.
- ☐ "A" Check soluble oil and anti-freeze solution, and add as needed.
- ☐ Change oil in air cleaner and crankcase breather.
- ☐ "A" Fill fuel tanks.
- ☐ Record oil pressure at 160° water temperature:
  At idling speed_____psi
  At governed speed_____psi
- ☐ Tighten or check tightness of:
  Lubricating oil lines and connections
  Fuel lines and connections
  Water manifold, piping and connections
  Air cleaner hose and connections.
- ☐ "A" Determine and correct causes of reported:
  Low lubricating oil pressure
  Low fuel pressure
  Abnormal water or oil temperature
  Unusual engine noise
  Poor combustion, if evidenced by excessive smoke.

"A" These operations are repeated from "A" checks.

Mechanic _____

Inspector _____

Fig. 3-3. "B" Maintenance operations

2. Lift the strainer pack assembly from the capscrew and case. Plug the open tube ends of the strainer with cork stoppers to keep dirt out of the strainer pack assembly.

3. Inspect the dirty element for the amount of dirt or sludge collected, and metal particles, bearing metal, grit, etc. If the strainer is packed full of dirt and sludge, it has probably been inoperative and this is a definite indication of poor operating conditions or inadequate maintenance. If the dirty element contains any bearing metal, it is an indication of a possible bearing failure in the near future. *This calls for an immediate inspection of the connecting rod and main bearing shells.*

4. Clean the assembly by washing in carbon tetrachloride, trichloroethylene or some other satisfactory cleaner such as Bendix carburetor cleaner, etc. Drain or blow off cleaning fluid.

5. Clean the inside of the case thoroughly in solvent and dry with compressed air. The capscrew has a retainer ring to prevent the washer and spring from being lost. Do not remove the capscrew, ring, washer or spring.

6. Remove the cork stoppers and reassemble the strainer in proper order as removed.

7. Make sure the rubber seal ring between case and cover is in good condition.

8. Fill strainer case with clean lubricating oil. This will aid in priming the lubricating system.

9. Tighten the capscrews to 75 to 100 inch pounds. *Extreme tightening will distort the case and cut the rubber seal ring.*

NOTE: Many operators find it profitable to carry an extra strainer element in stock as a service replacement unit and allow the dirty element to soak in solvent overnight. This saves cleaning time.

DRAIN FUEL FILTER: 1. Remove the drain plug from the bottom of the fuel filter case and drain out any accumulated water and sediment. Fig. 3-4.

2. Replace the drain plug and refill the filter case with clean fuel.

Fig. 3-4. Drain fuel filter

CHANGE OIL IN AIR CLEANER: (Oil-Bath Type): Fill the oil cup to the level indicated by the bead on its side with clean, fresh oil and assemble to cleaner. An oil of the same grade as that in the crankcase should be used in the cleaner; however, in extremely cold weather a lighter grade may be necessary. Some detergent, or additive, oils tend to foam in the air cleaner. The additives are of no advantage in the cleaner and for these reasons it is recommended that a straight mineral oil be used.

Warning: Never Use Crankcase Drainings.

CHANGE OIL IN CRANKCASE BREATHER: Fill the breather oil cup to the level indicated with oil of the same grade as used in the engine.

RECORD LUBRICATING OIL PRESSURE: Start the engine and bring up speed and temperatures slowly until the water temperature gauge reads 160° F. A comparison of pressure at idling speed with previous readings will give an indication of progressive wear of lubricating oil pump, bearings, shafts, etc. These readings are more accurate and reliable when taken immediately after an oil change.

TIGHTEN CONNECTIONS: Tighten or check tightness of lubricating oil, fuel, air and water lines and connections.

CYLINDER HEAD STUD NUTS: Cylinder head stud nuts should be retightened at the first 500 gallon fuel consumption check on new or rebuilt engines. Thereafter, they should stay tight until heads are changed at the frame overhaul.

"C" Maintenance Operations Each 1000 Gallons Fuel Consumption

These maintenance operations should be made at each 1000 gallons fuel consumption interval. "A" and "B" operations are to be included in these operations as noted.

CHANGE LUBRICATING OIL BY-PASS FILTER ELEMENT: If the engine is equipped with a by-pass filter the element should be changed at this time. To change element:

1. Remove drain plug in lower part of housing and drain oil.
2. Loosen cover clamp bolts, but do not attempt to remove bolts completely or withdraw them so far as to shear locking pin in end of bolt.
3. Withdraw cover clamps to clear edge of cover, and lift off cover.
4. Unscrew and remove the threaded wing nuts.
5. Loosen the locknuts and release tension on bolts to remove the pack centering spider. (The four bolts in the legs of the centering spider are for the purpose of centralizing the pack assembly after the used packs have been replaced.)
6. Unscrew threaded pack hold-down assembly and remove.
7. Remove the packs by lifting with the bail.
8. Install a new pack, reversing the above procedures.
9. Add an extra three and one-half gallons of engine oil to the crankcase to fill the filter case and element.

"C" CHECK FORM—PROTECTIVE MAINTENANCE OPERATIONS

—— Perform Each 1000 Gallons Fuel Consumed, or Equivalent Mileage or Hour Interval——

Time In_____Date_____

Unit No._____ Time Out_____Shift_____

- ☐ "B" Change lubricating oil.
- ☐ "B" Clean the lubricating oil strainer element. Inspect the element for bearing metal.
- ☐ Change the lubricating oil by-pass filter element.
- ☐ "B" Drain sediment from fuel filter case.
- ☐ Check cooling system and add coolant as needed.
- ☐ Clean removable air cleaner tray or silencer screens.
- ☐ "B" Change oil in air cleaner.
- ☐ Clean and change oil in crankcase breather.
- ☐ "A" Fill fuel tanks.
- ☐ Lubricate cranking motor.
- ☐ Lubricate generator.
- ☐ Clean fuel inlet connection screens.
- ☐ Clean fuel pump screen.
- ☐ Check belts for wear, and adjust tension.

- ☐ "A" Determine and correct causes of reported:
  - Low lubricating oil pressure
  - Low fuel pressure
  - Abnormal water or oil temperature
  - Unusual engine noise
  - Poor combustion, if evidenced by excessive smoke.
- ☐ "B" Record oil pressure at 160° water temperature:
  - At idling speed_____psi
  - At governed speed_____psi
- ☐ "B" Tighten or check tightness of:
  - Lubricating oil lines and connections
  - Fuel lines and connections
  - Water manifold, piping and connections
  - Air cleaner hose and connections.

"A," "B": Repeat operations: See "A" or "B" charts as indicated.

Mechanic _____

Inspector _____

Fig. 3-5. "C" Maintenance operations

CHECK ENGINE COOLANT: 1. Check rust inhibitor and/or antifreeze concentration in engine coolant. If chromate compounds or other commercial rust inhibitors are used follow manufacturer's recommendations for addition of inhibitor to replace that lost by spillage.

2. A solution of 4% soluble oil and 96% water makes a good coolant which will prevent or control corrosion in most cases. It should not be used in combination with other inhibitors or with permanent-type antifreezes. Where soluble oil is the rust inhibitor used, check the concentration by the following simple method:

a. Draw coolant directly from the hot radiator and put 98 cc's in a 100 cc glass graduate.
b. Put one teaspoonful of common table salt in the graduate and shake vigorously to dissolve as much of the salt as possible.
c. Let the solution in the glass graduate stand in a warm room for 15 to 30 minutes to give time for complete separation of the soluble oil and water.
d. The number of cc's of soluble oil at the top of the graduate gives the percentage.

Fig. 3-6. Checking soluble oil solution

CAUTION: DO NOT RETURN USED FLUID TO THE RADIATOR BECAUSE THE SALT WOULD DRIVE THE OIL OUT OF SOLUTION AND CAUSE CORROSION.

3. To make a 4% soluble oil solution, use three pints of soluble oil to each ten gallons water.

CLEAN AIR CLEANER REMOVABLE TRAY-SCREEN: Immerse the tray screen in kerosene or cleaning solvent. Slosh the screen up and down several times. Dry thoroughly with compressed air.

NOTE: If the tray screen is extremely dirty or coated with varnish, it may be necessary to singe the screen with a flame. Be careful not to melt the tin plate on the screens.

AIR MAZE TYPE: Immerse the cleaner in kerosene or cleaning solvent. Dry thoroughly with compressed air. Dip the top portion of the strainer screen in lubricating oil of the same grade as used in the engine.

CLEAN AND CHANGE OIL IN CRANKCASE BREATHER: Immerse the breather in kerosene or cleaning solvent. Wash thoroughly. Dry with compressed air. Fill the breather oil cup to the level indicated with oil of the same grade as used in the engine.

LUBRICATE CRANKING MOTOR: Add a few drops of clean SAE #20 lubricating oil to the bearings of the cranking motor.

LUBRICATE GENERATOR: Use SAE #20 lubricating oil to lubricate the battery charging generator bearings. Fig. 3-7. Avoid over oiling which would damage wire insulation.

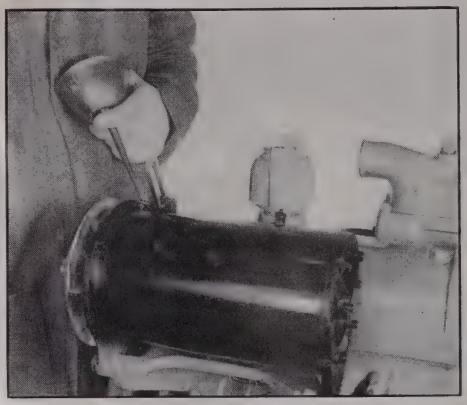

Fig. 3-7. Lubricate generator

CLEAN FUEL INLET CONNECTION SCREEN: Each fuel inlet connection has a fine mesh screen at the large or cage end. This screen is the last protection against dirt entering the injector, and since it is very fine mesh it will soon collect enough dirt from dirty fuel to restrict fuel delivery from the metering pump to the injector. This will result in loss of engine power or in uneven fuel charges and a rough running engine.

To clean: Remove the cage, gasket and strainer screen. Wash the screen in solvent and dry with compressed air. Reassemble as removed.

CLEAN FUEL PUMP SCREEN: The fine mesh filter screen in the PT fuel pump is located under the large cap at the top of the pump. See Fig. 3-8. It can be removed by loosening the cap and lifting out the spring and screen assembly. The screen can be separated from one of the screen retainers for easy cleaning, the other retainer is soldered to the screen. Replace the screen and retainer (the retainer with the hole

goes down) after cleaning. The spring is assembled on the screen assembly; the cone end of the spring may be assembled either up or down. Cap must be tightened to 20/25 ft. lb. with a torque wrench; excessive tightening is not required.

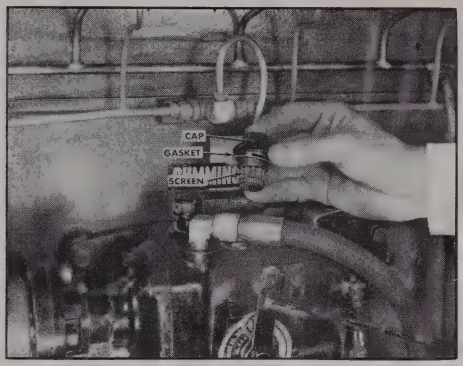

Fig. 3-8. Replacing the filter assembly

CHECK AND ADJUST BELTS: Belts are often neglected because a poorly adjusted belt does not bring an immediate penalty. A belt which is too tight puts a strain on gears, shaft and belt grooves. Loose belts slip, overheat and wear out more quickly. You can not cool the water in your radiator efficiently if the belts on the water pump are slipping. In replacing worn belts, use standard Cummins belts. They are shaped to assure proper fit in the groove, and are accurate and uniform in length to assure efficient operation. Where two belts are used they must be replaced as a pair.

The ⅜ inch JS fan belt, Part No. S-3204 needs to be adjusted to higher tension than most other belts to obtain best service life.

Adjust the tension of the S-3204 belt so that a 25 pound pull midway between pulley centers will deflect the belt 7/16 inch. Use a fish scale or any other small spring scale to check the adjustment.

Always loosen the adjusting device before installing a V belt. Never stretch a belt by prying or rolling it into the pulley groove because that will cause cord breakage and greatly reduce the life of any V belt.

"D" Maintenance Operations Each 2000 Gallons Fuel Consumption

These operations are to be performed at each 2000 gallons fuel consumption interval. "A", "B" and "C" operations are to be included in these operations as noted.

STEAM CLEAN THE ENGINE: There are many reasons why the exterior of the engine should be kept clean. Dirt from the outside will find its way into the fuel and lubricating oil filter cases and into the rocker housings when the covers are removed unless dirt is removed first.

Steam is the most satisfactory method of cleaning a dirty engine or piece of equipment. If steam is not available, use mineral spirits or some other solvent to wash down the engine.

Generator, [illegible] cranking motor openings and wiring should be protected from the full force of the steam jet.

IF NEEDED, FLUSH THE CRANKCASE: 1. During this lubricating oil drain, inspect the condition of the upper rockers and crankcase for sludge. Normally, if a good grade of heavy-duty oil has been used and operating temperatures have been kept in the correct range, there should be no sludge and crankcase flushing will not be needed. If inspection shows a large amount of sludge, the crankcase should be flushed with a mixture of five gallons of clean fuel oil and one-half to one gallon clean lubricating oil, or as much more flushing oil as is needed to bring and keep the level in the operating range.

2. Dirty lubricating oil filter elements should be removed before flushing.

3. Lubricating oil strainer elements should be changed or cleaned before and after flushing. If the engine is equipped with a Nugent bag-type strainer, use a special strainer bag saved just for flushing operations.

4. The radiator should be covered while running the engine at 800 to 900 rpm for approximately 15 minutes to bring the water temperature up to about 190° F. Sludge is heavy and gummy, and the flushing oil must be hot to cut it thoroughly.

5. Allow the flushing oil to drain at least 30 minutes. Unless all fuel oil used for flushing is

"D" CHECK FORM—PROTECTIVE MAINTENANCE OPERATIONS

—— Perform Each 2000 Gallons Fuel Consumed, or Equivalent Mileage or Hour Interval——

Time In_____Date_____

Unit No._____ Time Out_____Shift_____

- ☐ Steam clean exterior of engine. Protect electric wiring.
- ☐ Flush the crankcase, if needed.
- ☐ "B" Change lubricating oil.
- ☐ "B" Clean the lubricating oil strainer element. Inspect element for bearing metal.
- ☐ "C" Change lubricating oil by-pass filter element.
- ☐ Change fuel filter.
- ☐ Blow dust and dirt out of generator and cranking motor.
- ☐ Check generator brushes and commutator.
- ☐ "C" Lubricate cranking motor and generator.
- ☐ Check all electric wiring to generator, lights, cranking motor, battery and controls. Tighten and clean connections.
- ☐ Check air and vapor li[illegible]nnections. Clean and tighten.
- ☐ Check and
  Manifol[illegible] nut
  Oil pa[illegible]nting bolts
  Drive pulleys on shafts
  Engine mounting and bolts.
- ☐ Check thermal controls.
- ☐ "C" Check coolant solution, and add as needed.
- ☐ "C" Air cleaner:
  Clean removable tray or silencer screens.
- ☐ Change air cleaner oil.
- ☐ "C" Clean crankcase breather and change oil.
- ☐ "A" Fill fuel tanks.
- ☐ Check fuel pump and compressor drive couplings.
- ☐ "C" Clean fuel inlet connections screens.
- ☐ "C" Clean fuel pump screen.
- ☐ "C" Check belts for wear, and adjust tension.
- ☐ "A" Determine and correct causes of reported:
  Low lubricating oil pressure
  Low fuel pressure
  Abnormal water or oil temperature
  Unusual engine noise
  Poor combustion, if evidenced by excessive smoke.
- ☐ Inspect upper rollers, injector levers, injector plunger links and supercharger oil seals for lubricating oil loss.
- ☐ Check engine blow-by.
- ☐ Adjust valves and injectors.
- ☐ "B" Record oil pressure at 160° water temperature:
  At idling speed_____psi
  At governed speed_____psi
- ☐ "B" Tighten or check tightness of:
  Lubricating oil lines and connections
  Fuel lines and connections
  Water manifold, piping and connections
  Air cleaner hose and connections.

"A" "B" "C": Repeat operations as listed in form indicated.

Mechanic _____

Inspector _____

Fig. 3-9. "D" Maintenance operations

drained from the engine and oil pan, it will dilute the new lubricating oil. A gooseneck tube attached to a hand suction pump should be inserted through the oil pan drain plug hole to pump all flushing oil from the oil pan unless the pan is the type that drains completely.

6. Install new filter pack (if by-pass filter is used) and fill the crankcase with the proper grade lubricating oil. Three and one-half extra gallons oil are required for the Diesel-Pack filter and housing.

CHANGE FUEL FILTER ELEMENT: 1. Loosen the hex nut at the top of the fuel filter and turn off the top cover.

2. Take out the dirty filter element, clean the filter case, and install a new filter element.

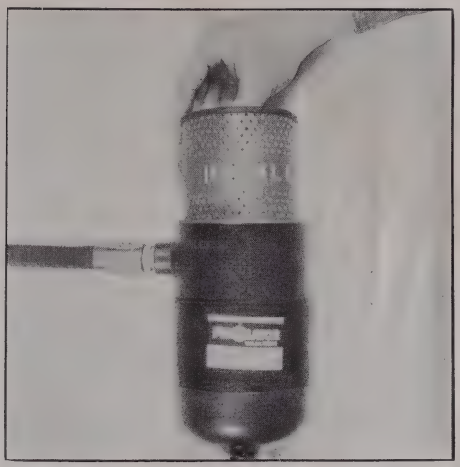

Fig. 3-10. Changing fuel filter element

BLOW DUST FROM GENERATOR AND CRANKING MOTOR: Dust and dirt, if allowed to accumulate in the generator and cranking motor, will cause excessive wear of bearings, brushes and commutator.

Remove the cover band and blow out the dust and dirt with a compressed air jet.

CHECK GENERATOR BRUSHES AND COMMUTATOR: The failure of a generator may cause unit down-time and nearly always results in expensive replacement.

1. Dirty commutators should be cleaned with No. 00 sandpaper; NEVER WITH EMERY CLOTH.

2. Replace worn brushes. If brushes wear rapidly, check for incorrect brush spring tension or high mica on the commutator. Check generator output and action of ammeter indicator after brush replacement.

3. Shorts and incorrect polarization can be detected at the ammeter. Incorrect polarization is indicated by minus reading when generator is turned. Take unit to electric service station for quick correction.

CHECK ELECTRIC WIRING: 1. Poor starting conditions are often traceable to loose or corroded battery connections. A loose connection will overwork the generator and regulator and shorten their life.

2. Add water to battery cells to keep tops of plate covered.

3. Remove corrosion from and around terminals, then coat with vaseline.

4. Keep connections clean and tight. Prevent wire and lugs from touching each other or any metal except screw terminals to which they are attached.

5. Replace broken or worn out wires and their terminals.

6. Have battery tested periodically for any faults by competent agency. Follow battery manufacturer's instructions for maintenance.

CHECK AIR AND VAPOR LINE CONNECTIONS: All air and vapor lines and connections from compressor, supercharger, rocker housing cover and cylinder heads should be checked and corrected as needed.

In cold weather, the condensed moisture in air tanks and lines may freeze and make brakes useless.

Air tanks should be drained and all water must be kept out of the brake system.

TIGHTEN MANIFOLD NUTS: Exhaust, intake and water manifolds should be checked for tightness. Fig. 3-11.

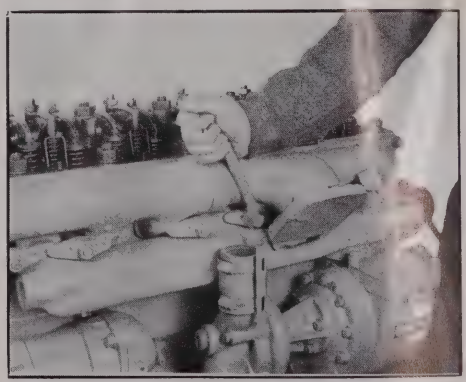

Fig. 3-11. Tighten manifold stud nuts

TIGHTEN OIL PAN MOUNTING BOLTS: The only way to insure that nuts or capscrews are tight is to put a wrench on them and try them. Replace all lost or broken bolts.

CHECK DRIVE PULLEYS: 1. Check drive pulleys to see that they are tight on their shafts and that keys are not sheared.

2. Tighten the locknuts for drive pulleys.

TIGHTEN MOUNTING BOLTS: Mounting bolts will occasionally work loose and, if they do, the supports and brackets will wear rapidly. Tighten all mounting bolts or nuts and replace any broken or lost bolts or capscrews.

CHECK THERMAL CONTROLS: Thermostats: 1. Check opening and closing of main line and by-pass thermostats. This can be done by immersing the thermostats in water and slowly bringing the water temperature to thermostat operating temperature.

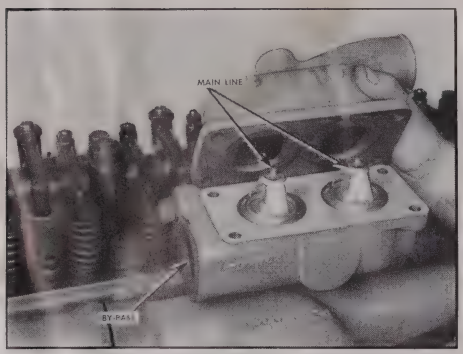

Fig. 3-12. Thermostats

2. Main line thermostats should open at 170° F. to 175° F. By-pass thermostats should close at 190° F. to 195° F. These temperatures are for latest type thermostats.

CAUTION: MAIN LINE THERMOSTATS MUST ALWAYS OPEN AT A LOWER TEMPERATURE THAN THE CLOSING TEMPERATURE OF THE BY-PASS THERMOSTAT.

Radiator Shutters: Thermostat controlled radiator shutters, when used in conjunction with main line and by-pass thermostats in the engine, should be set to open at 175° F. The shutters should close at 168° F.

CHECK FUEL PUMP AND COMPRESSOR DRIVE COUPLINGS: Ordinarily, the fuel pump coupling or the compressor drive chain will not need replacement during the service period of the engine; however, it takes only a moment to check them for wear or damage.

CHECK FOR OIL LOSS: Excessive consumption or loss of lubricating oil may be caused by any one or more of the following conditions. These must be corrected at any time they develop.

Oil Leaks: Oil leaks may develop anywhere on the pressure side of the oil pump. Check all lines and connections carefully at this period. Test with a wrench.

Piston Rings: 1. Stuck piston rings can often be detected by observing blow-by in the crankcase. Sticking of rings is caused by (a) excessive idling, (b) low operating temperatures, (c) poor fuel, (d) overload, etc.

2. Broken piston rings result in scored cylinder liners and loss of lubricating oil.

3. Pistons with oil drain holes filled with carbon will cause excessive use of lubricating oil. This condition is caused by the same type of poor operation that causes sticking of rings.

Injector Plunger Links: 1. Drillings in the injector rocker levers carry lubricating oil under pressure to the injector plunger links. See Fig. 1-7. If these links wear so they permit leakage between the plunger link and the rocker lever socket, the oil will run down the injector housing and drain to the fuel tank where it will be recirculated and burned.

2. Particular care must be exercised to change the rocker lever socket, if it is worn, when injectors are changed.

Oil Seals of Supercharger: 1. The oil seals of the supercharger should be inspected for leakage if excessive lubricating oil loss is encountered. Oil that leaks around the supercharger seals is carried into the cylinders with intake air and burned as fuel.

2. The appearance of "wet" oil at the ends of the rotors, and excessive oil consumption should be cause for changing supercharger seals.

3. Check supercharger lubricating oil lines and connections for leaks. Correct as needed.

Oil Seals of Turbocharger: 1. The presence of "wet" oil on the inside surface of the blower (or compressor wheel) housing may be an indication that the piston-ring-type oil seals of the turbocharger are leaking. Install new seals if needed.

NOTE: Oil overflow in the air cleaner also will draw "wet" oil through the blower housing. Be sure to eliminate this possibility before changing oil seals.

2. Excessive exhaust smoke, accompanied by burned oil deposits around the exhaust turbine shaft and wheel may indicate oil seal leakage on the turbine side. Again, a close investigation is necessary to determine whether oil leakage is coming from the turbocharger or from worn pistons, rings, liners, etc.

CHECK ENGINE BLOW-BY: Engine blow-by, or escape of combustion gases past the piston and liner, is caused by worn or stuck piston rings, and worn or scored pistons or cylinder liners.

Blow-by can be detected by running the engine and observing the gas escape from the lubricating oil filler hole with the cap or breather removed. There will always be some gas escape at this point when the lubricating oil is up to operating temperature due to heat and piston movement, but distinct puffs indicate blow-by. Experience and comparison with other units operating at the same speed are needed to make a conclusion as to the extent of blow-by. Real blow-by is always accompanied by excessive lubricating oil consumption. It can be corrected only by installing new rings, pistons or liners as needed.

ADJUST VALVES AND INJECTORS: J, JS, JT Engines: Injector plungers and valves should be adjusted before starting the engine the first time, after the first 50 hours service and every 2000 gallons fuel consumed thereafter.

Injector plungers and valves are adjusted 90° after top center firing position, and fan drive pulleys are so marked.

ENGINE FIRING ORDER: 1-5-3-6-2-4. Cylinders are numbered from front of engine.

POSITIONS FOR INJECTOR AND VALVE ADJUSTMENTS: 1. Pull the compression release lever back and block in the open position. This lifts all intake valves and makes it possible to turn the crankshaft without working against compression.

2. Bar the engine in its operating direction to No. 1 Top Center Firing position. In this position, both intake and exhaust valves will be closed for No. 1 cylinder.

3. Continue to rotate the crankshaft in its operating direction one-quarter turn and the "1-6VS" mark on the fan drive pulley will line up with the timing mark on the gear case cover. The engine is now in position to adjust the injector plunger and valves for No. 1 cylinder. Fig. 3-13.

4. Adjust injector plunger and valves of No. 1 cylinder as directed in succeeding paragraphs under ADJUSTING INJECTOR PLUNGERS and VALVE ADJUSTMENT.

5. Rotate the crankshaft in operating direction to the next "VS" mark corresponding to firing order of the engine. For right-hand six-cylinder engines this will be "2-5VS" and the cylinder ready for adjustment will be No. 5.

6. Continue rotation of crankshaft in operating direction and continue adjustments until all injectors and valves have been correctly adjusted.

CAUTION: TWO COMPLETE REVOLUTIONS OF THE CRANKSHAFT ARE NEEDED TO SET ALL INJECTOR PLUNGERS AND VALVES. INJECTOR AND VALVES CAN BE ADJUSTED FOR ONLY ONE CYLINDER AT ANY ONE SETTING.

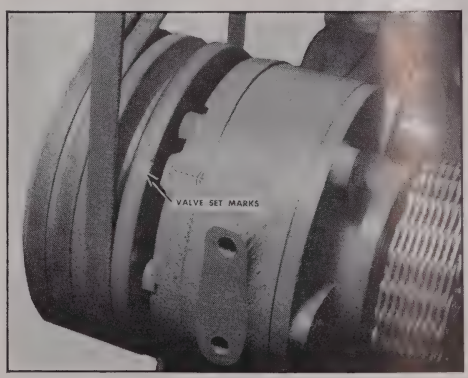

Fig. 3-13. Valve set marks

ADJUSTING INJECTOR PLUNGERS: 1. Adjust injector plungers and valves in valve-set position for the cylinder being adjusted as detailed in previous paragraphs under POSITIONS FOR INJECTOR AND VALVE ADJUSTMENTS:

2. Check threads of injector adjusting screw and nut to see that they are clean, well oiled, and free-turning.

3. With engine in valve-set position for injector being adjusted, turn the injector adjusting screw down until the plunger contacts the cup, and advance an additional 15 degrees to squeeze oil out of cup.

4. Loosen the adjusting screw one turn.

5. Use a torque screw driver or an accurately calibrated torque wrench to tighten the injector adjusting screw to the torque shown:

Temporary Adjustment: 4 foot-pounds with oil temperature at 70° F.

Final Adjustment: 5 foot-pounds with oil temperature at 140° F.

6. Do not use hold-down tools or injector adjusting clips when adjusting injectors by the torque method.

NOTE: Some of the first JS engines built have template marks 15° apart on the injector rocker levers. These marks can be disregarded when adjusting injectors by the torque method.

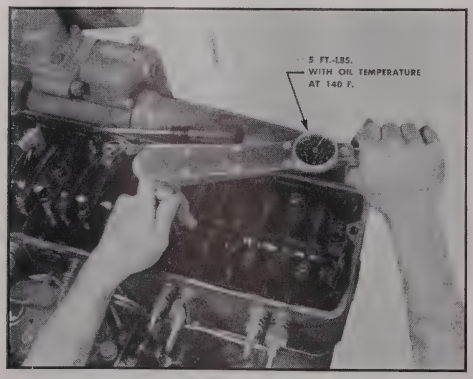

Fig. 3-14. Adjusting injector plunger

VALVE ADJUSTMENT: 1. The same engine position used in setting the injector is used for setting the intake and exhaust valves.

2. Make sure the compression release is in running position before setting the intake valves.

3. Loosen the valve adjusting lock nut and back off the adjusting screw.

4. With a feeler gauge of proper thickness for the valve being adjusted inserted between the rocker lever and valve stem, turn the adjusting screw down until the lever just touches the feeler gauge. Lock adjusting screw in this position with the jam nut. Fig. 3-15.

5. Always make final valve adjustments after injectors are adjusted, and with the engine warm (oil temperature 140° F.). Set intake valves with .015 clearance, and exhaust valves with .025 clearance.

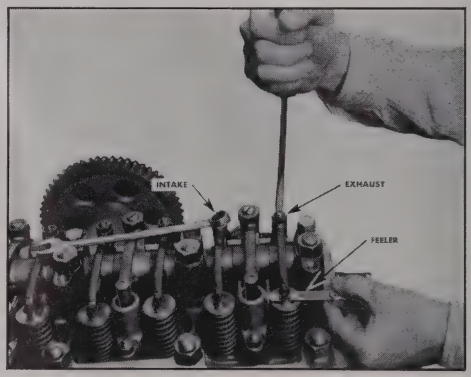

Fig. 3-15. Valve adjustment

"E" Maintenance Operations Each 4000 Gallons Fuel Consumption

These operations are to be performed at each 4000 gallons fuel consumption interval. "A", "B", "C" and "D" operations included in these checks are as noted.

"E" CHECK FORM—PROTECTIVE MAINTENANCE OPERATIONS

—— Perform Each 4000 Gallons Fuel Consumed or Equivalent Mileage or Hour Interval ——

Time In_____ Date_____

Unit No._____ Time Out_____ Shift_____

- ☐ "D" Steam clean exterior of engine. Protect electric wiring.
- ☐ Drain and flush radiator.
- ☐ "D" Flush the crankcase, if needed.
- ☐ "B" Change lubricating oil.
- ☐ "B" Clean the lubricating oil strainer element. Inspect element for bearing metal.
- ☐ "C" Change the lubricating oil by-pass filter element.
- ☐ Check crankshaft end clearance with indicator gauge.
- ☐ "D" Change fuel filter.
- ☐ "D" Blow dust and dirt out of generator and cranking motor.
- ☐ "D" Check generator brushes and commutator.
- ☐ Grease cranking motor drive bearing.
- ☐ "C" Lubricate cranking motor and generator.
- ☐ "D" Check fuel pump and compressor drive couplings.
- ☐ "C" Clean fuel pump screen.
- ☐ "A" Fill fuel tanks.
- ☐ "D" Check all electric wiring to generator, lights, cranking motor, battery and controls. Tighten and clean connections.
- ☐ "D" Check air and vapor line connections. Clean and tighten.
- ☐ Grease fan hub.
- ☐ Clean injectors.
- ☐ "D" Check and tighten:
  - Manifold stud nuts
  - Oil pan mounting bolts
  - Drive pulleys on shafts
  - Engine mounting and bolts.
- ☐ "D" Check thermal controls.
- ☐ "C" Check the cooling system solution and add as needed.
- ☐ "C" Clean air cleaner and change oil.
- ☐ "C" Clean crankcase breather and change oil.
- ☐ Check air inlet restriction. If more than 18 inches of water, steam clean the air cleaner non-removable screens.
- ☐ "C" Clean fuel inlet connections screens.
- ☐ "C" Check belts for wear, and adjust tension.
- ☐ "A" Determine and correct causes of reported:
  - Low lubricating oil pressure
  - Low fuel pressure
  - Abnormal water or oil temperature
  - Unusual engine noise
  - Poor combustion, if evidenced by excessive smoke.
- ☐ "D" Inspect upper rollers, injector levers, injector plunger links and supercharger oil seals for lubricating oil loss.
- ☐ "D" Check engine blow-by.
- ☐ "D" Adjust valves and injectors.
- ☐ "B" Record oil pressure at 160° water temperature:
  - At idling speed_____psi
  - At governed speed_____psi
- ☐ "B" Tighten or check tightness of:
  - Lubricating oil lines and connections
  - Fuel lines and connections
  - Water manifold, piping and connections
  - Air cleaner hose and connections.

"A" "B" "C" "D": Repeat operations as listed for forms indicated.

Mechanic _____

Inspector _____

Fig. 3-16. "E" Maintenance operations

DRAIN AND FLUSH RADIATOR: Since the operating temperatures are dependent on the efficiency of the cooling system, it is apparent that it should function at its best. If the radiator is allowed to become dirty on the outside or inside, it loses efficiency with detrimental effect on the engine.

1. Drain and flush the radiator.

2. Refill with a 96% water and 4% soluble oil mixture or add other rust inhibitor or anti-freeze. See Page 3-7, "C" operation check.

CHECK CRANKSHAFT END CLEARANCE: The crankshaft of a new or newly rebuilt engine should have .004" to .009" end clearance. A worn engine should not be operated with more than .030" crankshaft end clearance.

The check can be made by attaching an indicator to rest against the flywheel or end of the crankshaft while prying the crankshaft fore and aft. End clearance must be present with engine mounted to its driven unit.

Insufficient end clearance will cause excessive wear of the crankshaft flange and thrust bearings. It often results in bearing and engine failure.

Excessive thrust bearing or flange wear is generally caused by poor mounting of driven unit or by riding the clutch or other poor operating practices. End clearance in excess of .035 may result in bossing of connecting rods in pistons.

GREASE CRANKING MOTOR DRIVE BEARING: 1. Remove the cranking motor and pack the reservoir with graphite grease. Do not lubricate excessively, since excessive greasing may cause gumming of the commutator and reduce cranking ability of the motor.

2. On some models, oil wicks are used for lubrication of the center, or drive end, bearing. Saturate this wick with clean SAE 20 lubricating oil.

3. Check brushes and commutator.

GREASE FAN HUB: Fill the fan hub, through the pressure relief fitting with sodium-soap-base ball bearing grease.

NOTE: Some earlier model JS fan hubs do not have pressure relief fittings. To grease these hubs, two plugs must be removed while lubricating to prevent breaking the bearing seals through excessive grease pressure.

CLEAN INJECTORS: The grade of fuel used, the engine operating temperatures and the accuracy of injector adjustments will determine how often it will be necessary to clean injectors. Cleaning is definitely a bench job, and it is not good practice to tie up a unit while this operation is being performed. See Bulletin No. 6395 for removal, cleaning and replacement instructions.

CHECK AIR INLET RESTRICTION: 1. The air inlet restriction, as measured with a manometer at the supercharger, or turbocharger inlet connection, should not exceed 18 inches of water at maximum governed rpm. If the restriction exceeds 18 inches of water, correct as follows:

A. Steam clean the air cleaner main body screens. Direct the steam jet from the air outlet side of the cleaner to wash dirt out in the opposite direction of air flow.

B. Check for sharp bends in air inlet piping. Sharp bends restrict air flow.

C. Check to be sure the inside diameter of the piping between the cleaner and the engine, or of the extension above the air cleaner, is no smaller than the flange connections of the air cleaner.

D. Repair or replace any dented or mashed air cleaner piping, rain shield or air cleaner housing.

2. After all corrective measures have been taken, re-check the air inlet restriction. If the restriction is 7 to 14 inches of water at maximum governed rpm, the engine is getting plenty air.

"F" Maintenance Operations Each 16,000 To 20,000 Gallons Fuel Consumption

The "F" maintenance operation is usually referred to as the frame overhaul because at this period all worn units which can be removed without taking the engine from its frame are replaced with new or rebuilt units.

Unlike the "A", "B", "C", "D", and "E" checks, the frame overhaul need not be performed solely on the basis of total accumulated fuel consumption, or period of service. Oil consumption, oil pressure at idling, dilution and other signs of wear should be taken into consideration before starting the frame overhaul.

At this period, first inspect the main and connecting rod bearings, then, the pistons and liners. If any of these parts have reached the worn replacement limit, it is time for the overhaul; if not, you probably will find it economical to operate an additional period corresponding to 8,000 gallons fuel consumption before you do the frame overhaul.

The sole purpose of unit replacements at the frame overhaul is to prevent on-the-job failures. Very few parts of any unit will be worn badly, and the unit rebuild costs will be low *if all parts*

"F" CHECK FORM—PROTECTIVE MAINTENANCE OPERATIONS

—— Perform Each 16,000 Gallons Fuel Consumed, or Equivalent Mileage or Hour Interval——

Unit No._____ Time In_____Date_____

Time Out_____Shift_____

- ☐ "D"Steam clean exterior of engine. Protect electric wiring.
- ☐ "E"Drain and flush radiator.
- ☐ "E"Check crankshaft end clearance with indicator gauge.
- ☐ Inspect crankshaft, main bearings and connecting rod bearings. Replace if worn beyond replacement limits.
- ☐ Inspect pistons and liners, and replace if worn beyond limits.
- ☐ Install new piston rings.
- ☐ Remove and clean:
  - Heat exchanger, or oil cooler
  - Oil pan.
- ☐ Remove the following engine units and replace with rebuilt units:
  - Cylinder heads
  - Upper and lower rocker lever housings and levers
  - Lubricating oil pump, if worn
  - Fuel pump
  - Injectors and inlet connections
  - Water pump
  - Supercharger
  - Air compressor.
- ☐ Inspect drive unit bearings and replace units, if needed.

"A" "B" "C" "D" "E": Repeat operations as listed for forms indicated.

- ☐ Clean air intake and exhaust systems.
- ☐ "D"Blow dust and dirt out of generator and cranking motor.
- ☐ "D"Check generator brushes and commutator.
- ☐ "D"Check all electric wiring to generator, lights, cranking motor, battery and controls. Tighten and clean connections.
- ☐ "D"Check air and vapor line connections. Clean and tighten.
- ☐ "D"Check thermal controls.
- ☐ "C"Check the cooling system solution and add as needed.
- ☐ "E"Check air inlet restriction.
- ☐ Check exhaust back pressure.
- ☐ "A"Fill fuel tanks.
- ☐ Complete lubrication of engine. Change all fuel and lube filters.
- ☐ "D"Adjust valves and injectors.
- ☐ "B"Record oil pressure at 160° water temperature:
  - At idling speed_____psi
  - At governed speed_____psi
- ☐ Road test the engine.

Mechanic _____

Inspector _____

Fig. 3-17. "F" Maintenance operations

which are not worn beyond the replacement limits are re-used. On the other hand, it definitely would not be economical to exchange units at the "F" period if all wearing parts were replaced regardless of the amount of wear.

INSPECTION: 1. A preliminary inspection of parts not susceptible to removal during a frame overhaul must be made to determine whether the engine must be removed from its mounting.

2. Crankshaft rod journals should not be worn or out-of-round more than .0015 at this inspection.

3. After removal of valve and injector tappets, the camshaft lobes can be inspected. If they are scuffed, scored or cracked, the camshaft must be replaced. Camshaft bearings do not ordinarily need replacement at this interval.

4. Gears and flywheels can be disregarded at this inspection unless there is noise in the gear train or a broken ring on the flywheel.

BEARING SHELLS: 1. Change connecting rod bearing shells if worn more than .0015", and main bearing shells if worn more than .002". Measure shell thickness with a dial indicator comparator gauge and compare with new shell thickness.

2. Bearing shells should not be re-used, if bearing metal has been pounded out, if they are badly scored, or if there is more than .002 difference in clearance of adjacent main bearings.

3. Never use lead ribbons or feeler gauges between shells and journals to measure clearance. They distort the lead plating on the shells. Bearing clearance is determined by gauging crankshaft bore, crankshaft journals, and bearing shell thickness.

CYLINDER LINERS: Gauge the cylinder liners. If they are worn in excess of .004 at point of greatest wear, replace them with new or re-ground liners.

PISTONS AND RINGS: 1. Pistons should be replaced new if ring grooves are worn more than .003 wider than those in a new piston of the same part number.

2. Use new piston rings.

CONNECTING RODS: 1. Have connecting rods rebuilt by your Cummins Dealer if piston pin bushings are worn in excess of 1.5015. New piston pin bushings should be line-bored with special equipment.

2. When rod caps are tightened to operating tension, the crankpin bore should be 2.7725/2.773. They should not be used if out-of-round more than .0015 or if the minimum dimension is less than 2.7715.

3. Connecting rods should receive magnetic inspection before installation in the rebuilt engine. No rods should be used if they show cracks in this test.

HEAT EXCHANGER OR OIL COOLER: Oil Side: 1. Immerse the core in a container of carbon tetrachloride, trichloroethylene or some other approved cleaning solvent.

2. Let the unit stand in solvent for several minutes.

3. Force the liquid through the unit in the reverse direction from operating flow until thoroughly cleaned.

Water Side: 1. Immerse the core in a solution of one part muratic acid and nine parts water, to which has been added one pound of oxalic acid and .01 gallon of pyridine to each five gallons of acid and water solution.

2. Remove the core when foaming and bubbling stops. This usually takes from 30 to 60 seconds.

3. Immerse the unit in a 5% solution of sodium carbonate. Remove when bubbling ceases and pressure flush with clean warm water.

4. Clean the inside of the case thoroughly with steam, solvent or both.

NOTE: Always clean the oil side of the cooler before the water side. After cleaning both sides of the core, flush oil passages with clean, light lubricating oil to remove all dirt particles.

OTHER ENGINE UNITS: Replace the following units with new or rebuilt units:

Cylinder Head
Rocker Lever Assembly
Fuel Pump
Injectors
Lubricating Oil Pump
Water Pump
Driving Units, if bearings are worn
Supercharger
Turbocharger
Air Compressor and/or vacuum pump
Generator and Cranking Motor

Send the old units to your Cummins Dealer for rebuilding.

CLEAN AIR INTAKE AND EXHAUST SYSTEMS: Thoroughly clean the intake manifold and the interior of all intake air piping to prevent any build up of dirt which will restrict air flow.

2. Check the exhaust manifold and exhaust piping to be sure there are no restrictions to prevent free escape of exhaust gasses.

CHECK EXHAUST BACK PRESSURE: The exhaust back pressure as checked with a manometer at the exhaust manifold outlet flange should not exceed 1.5 inches of mercury at maximum governed rpm for JS and JT engines or 1 inch of mercury for J engines.

"G" Maintenance Operations Each 32,000 To 40,000 Gallons Fuel Consumption

After 32,000 to 40,000 gallons fuel consumption, the engine should be removed from its mounting and be completely rebuilt.

The overhaul or complete rebuild must be performed in a well-equipped shop by well-trained mechanics. Your Cummins Dealer has the special tools and the up-to-date information necessary to rebuild the engine to factory specifications.

After an engine has been rebuilt it is essentially a new engine and should be treated as such. By treating the rebuilt engine like a new engine and by following the protective maintenance schedule, the same dependable service can be expected from the engine that it gave during its first service period.

"G" CHECK FORM—PROTECTIVE MAINTENANCE OPERATIONS

—— Perform Each 32,000 Gallons Fuel Consumed or Equivalent Mileage or Hour Interval ——

Time In_____Date_____

Unit No._____ Time Out_____Shift_____

☐ Remove engine from chassis and replace with completely rebuilt engine.

☐ Road test rebuilt engine.

Notes

_____

_____

Mechanic _____

Inspector _____

Fig. 3-18. Complete engine rebuild operation

Never let anyone tinker with your Cummins Diesel or suggest the addition of extra accessories or the substitution of parts which were not original equipment. Cummins Engine Company, Inc., has spent years in developing and testing every working part. When you change one part, you upset its relationship to the whole unit. *Always use genuine Cummins parts in your Cummins Diesel.*

ENGINE REBUILD INSTRUCTIONS: Complete instructions for engine disassembly, rebuilding, assembly and engine testing are given in the JS Shop Manual Bulletin No. 6395.

Maintenance Operations Summary

The "Engine Maintenance Operations Summary" reproduced in Fig. 3-19 can be used as a complete record of the engine during its entire service period. All maintenance checks, parts replacements, fuel and oil consumption, etc., will be shown on this sheet after they are posted from the other work sheets. The record will show the value of protective maintenance.

All the maintenance forms shown in this manual are available from your Cummins Dealer.

CLEANLINESS

Abrasives are useful for grinding away excess metal during manufacture, but they must be kept out of the engine. Excessive dirt in air, in fuel, or in lubricating oil will cause an engine to wear out in a fraction of the time regarded as its normal life. On the other hand, if *all* dirt could be kept out of the engine it would give many times the "normal' service. *MOST WEAR IS CAUSED BY DIRT.*

A clean, well organized shop is an advertisement of good maintenance. Fig. 3-20. No day is so rushed that a few minutes can not be profitably spent in shop cleaning. The easiest way to keep a place clean is keep the dirt outside. If equipment is cleaned thoroughly before bringing into the shop there will be less dirt to take out.

Lubricating oil changes, lubricating oil strainer

ENGINE MAINTENANCE OPERATIONS SUMMARY

NOTE: INCLUDE SUMMARY OF DAILY "A" REPORTS PERFORMED BETWEEN "B" OPERATIONS IN NEXT "B" REPORT.

ENGINE SERIAL NO. _____

OPERATIONS		DUE	PERFORMED	DATE	MECHANIC	LABOR	PARTS		FUEL	LUBE OIL	TIME LOST	EMERGENCY REPAIRS			REMARKS
CHECKS	FUEL GALLONS	MILEAGE or HOURS	MILEAGE or HOURS			HOURS	REQ NO	COST	GALLONS	QUARTS	HRS OUT OF SERVICE	LABOR	PARTS	TIME LOST—HRS	ACCIDENTS — CAUSE OF FAILURE — MAJOR ITEMS REPLACED, ETC.
B	500														
C	1000														
B	1500														
D	2000														
B	2500														
C	3000														
B	3500														
E	4000														
B	4500														
C	5000														
B	5500														
D	6000														
B	6500														
C	7000														
B	7500														
E	8000														
B	8500														
C	9000														
B	9500														
D	10000														
B	10500														
C	11000														
B	11500														
E	12000														
B	12500														
C	13000														
B	13500														
D	14000														
B	14500														
C	15000														
B	15500														
F	16000														
B	16500														
C	17000														
B	17500														
D	18000														
B	18500														
C	19000														
B	19500														
E	20000														
B	20500														
C	21000														
B	21500														
D	22000														
B	22500														
C	23000														
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E	24000														
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B	25500														
D	26000														
B	26500														
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B	27500														
E	28000														
B	28500														
C	29000														
B	29500														
D	30000														
B	30500														
C	31000														
B	31500														
G	32000														
TOTALS															

Fig. 3-19. Maintenance operations summary form

and filter element changes, fuel filter changes, cleaning of fuel screens, radiator, cooling systems and electric connections are operations performed for the sake of cleanliness.

Unless the outside of the engine is cleaned before the oil pan, housing covers or engine units are removed, and unless these operations are performed under clean working conditions, the foreign dirt allowed to fall into the engine may cause more damage than that being removed.

Instructions for cleaning engines and engine units are outlined in the "Scheduled Maintenance Operations" of this section.

Fig. 3-20. A clean shop

AIR

The engine can not burn the fuel completely without a plentiful supply of air. In fact, the amount of fuel that can be burned is limited almost entirely by the air supply. Therefore, it becomes apparent that the maintenance department must be concerned with providing the conditions that will permit the engine to get the maximum amount of air into the combustion chamber.

In warm climates the air intake should be located outside the hood or cover to get cool air and a greater volume of air. If possible, the air cleaners also should be located outside the hood to prevent overheating and expansion of intake air. Air cleaners must be large enough to permit free unobstructed air intake. It is important that the air be clean. Air containing dust will cause extremely high wear of cylinder liners, rings, pistons and other engine parts.

The air cleaner takes the dust from the air but the mechanics must take the dust and dirt from the air cleaner. Clean oil of the same grade as used in the engine should be used in the air cleaner and air breather.

The air intake restriction should be checked periodically to be sure the engine is getting plenty air. Instructions for checking air restriction are given on Page 3-16.

LUBRICATION

Lubricating oil diagrams are shown on Pages 1-7 and 1-8.

Recommended Lubricating Oil Specifications

The following grades of lubricating oils should be used in the crankcase:

Hot Weather (90° F. and above).....SAE No. 30
Average Weather (32° F. to 90° F.)....SAE No. 20
Cold Weather (below 32° F.).....SAE No. 10W

The SAE numbers given should be adhered to closely. It would not be satisfactory, for instance, to substitute an SAE No. 30 light grade, or SAE No. 20 light grade, for the corresponding straight SAE No. 30 or SAE No. 20.

We do not recommend any fixed brands of oil for crankcase lubrication. We do, however, recommend that only the oils manufactured by a recognized concern and the best quality obtainable be used.

The term "best quality" as used here refers to lubricating characteristics rather than to premium grades of high-additive oils. If the fuel used contains less than one percent sulphur and if recommended operating temperatures are maintained, it will not be necessary to use premium-grade Series 2 lubricating oils in Cummins Diesels.

Crankcase Lubrication

Providing and maintaining an adequate supply of clean, high-quality lubricating oil, and of the proper grade, in the engine crankcase is one way of insuring long engine life and satisfactory performance.

Lubricating oil in an engine has three important functions:

A. It provides a smooth film between bearing surfaces to reduce friction.

B. By circulation, it dissipates the heat generated by friction at the bearing surfaces.

C. It acts as a seal between piston rings, pistons and cylinder walls.

Engine speed and load, oil clearances, oil viscosity and operating temperatures are factors to be considered in maintaining the proper balanced conditions.

It is always a serious mistake to use oil of too heavy grade in an engine. When the oil is too heavy, the flow is retarded and some closely fitted parts may receive little or no oil. This results in increased friction, expansion from heat and premature failure.

Different brands or different grades of lubricating oil should never be mixed in the crankcase. It is best to choose carefully the best oil available and then continue to use that brand in the proper grade, or weight, consistent with weather conditions and engine wear.

Bearings and shafts may be ruined in a few seconds, if run without oil. All new or newly rebuilt engines, or engines that have been in storage, should have lubricating oil pumped through the system with some type of auxiliary hand or power pump before starting. The pipe or tube from the pump can be attached to the oil header on the side of the engine after removing one of the socket-head screws from the block.

Make sure that all oil passages are open and that all connections are tight. Leaks in suction lines will permit introduction of air which will result in foaming of oil and inadequate lubrication.

Keep the oil level in the crankcase in the safety range as shown by the marks on the dipstick furnished with the engine.

Oil Pan Capacity

The dipstick, or bayonet gauge, furnished with each Cummins oil pan has two markings, "H" and "L." The "H" represents the high level to which oil pan should be filled and with the lubricating oil filters saturated. The "L" on the dipstick represents the lowest level at which it is safe to operate the engine. The oil level should be maintained as near the high level as possible at all times.

NOTE: Add extra oil to make up for that absorbed by the oil filter or strainer elements when elements are changed.

J, JS and JT engines have a capacity at high level of four gallons and at low level three gallons.

It must be remembered that oil pans must not be so full that connecting rods or crankshaft counterweights will dip in the oil under any operating conditions, and the level must never be low enough to uncover the end of the suction tube.

Lubricating Oil Pressure

At maximum engine speed, the lubricating oil pressure should be maintained at 30-50 psi. At idling, it may safely drop to as low as 5-15 psi. Extreme or abnormal variations in lubricating oil pressure should be investigated and corrected. Low lubricating oil pressure may be caused by:

1. Dilution of lubricating oil.
2. Insufficient supply of oil.
3. Loose, broken or bent connections and piping.
4. Dirty gauge line.
5. Excessive wear of lubricating oil pump.
6. Worn bearings.
7. Excessive leaks around push tubes and rocker levers.

Dilution Of Lubricating Oil

Dilution of lubricating oil may be caused by one or more of the following conditions:

1. Stuck piston rings.
2. Overload: More fuel is being injected than will burn in the available air.

3. Injector cup gasket leaking: Cup leak can be detected by build-up of fuel around the body, while it is in the cylinder head and the engine is running.
4. Fuel inlet or drain connections leaking.
5. Injector drain lines and manifold not draining properly to fuel pump.
6. Worn injector plungers permitting excess by-pass of fuel.
7. Vacuum in crankcase caused by air-tight or dirty breather cap.
8. Injector cup spray tip cracked.

Oil Temperatures

The ideal operating temperature for lubricating oil in the crankcase is 180° F. Some engines operating in hot climates or over rough terrain may need oil coolers to control oil temperature.

FUEL

Fuel oil serves two purposes in your Cummins Diesel. First, it supplies the energy for all the work done by the engine and, second, it lubricates many of the parts in the fuel system.

The fuel must burn readily and completely in the engine. Operating methods and maintenance affect combustion to a large degree. Favorable operating temperatures must be maintained, a plentiful supply of air must be provided, and the engine must be kept in good mechanical condition to get the most energy from the fuel. The fuel must be of a grade and quality that meets engine requirements. Water and dirt do not burn.

Cummins fuel pump and injector parts are accurately made and closely fitted to provide accurate metering and injection of the fuel. They are lubricated by fuel oil. Unless the fuel oil has good lubricating qualities, these parts will soon be damaged and must be replaced. Any fuel oil that contains water, abrasives or sulphur in excess of the tolerances permitted in our recommended fuel oil specifications may cause extensive damage to the engine.

Recommended Fuel Oil Specifications

Fuel oil should be a neutral distillate petroleum oil, free from suspended matter, and not a mixture of light oil and heavy residue.

Physical and chemical properties should meet the following requirements:

Viscosity @ 100° F.
- Centistokes—2.4 minimum—5.0 maximum, or
- Saybolt Universal—34 minimum—42 maximum

Gravity—Degree A.P.I.—30 minimum—42 maximum

Cetane Number—45 minimum—except that in warm weather and where no starting difficulties are encountered, the cetane number may be a minimum of 40.

Pour Point—10° F. below lowest temperature expected

Distillation
- At least 10% should distill below 460° F.
- At least 90% should distill below 675° F.
- End point should not exceed 725° F., minimum recovery—98%

Conradson Carbon Residue—Not to exceed .25% on 10% bottoms

Ash—Not to exceed .02% of weight

Bottom Sediment and Water—Maximum .05% of weight

Sulphur—Not to exceed 1% of weight

Copper Strip Corrosion—3 hours @ 122° F.—Pass

Effects Of Poor Fuel On Engine Operation

Acids in the fuel may be either mineral or organic-type. Mineral-type acids are, as a general rule, highly corrosive to the fuel pump and injector parts. Furthermore, dilution of lubricating oil by fuel oil containing mineral-type acids may cause extensive damage to engine bearings.

Heavy residue is the principal cause of excessive deposits on injectors, in the combustion chamber, and in the exhaust ports. Plugged injector spray holes, stuck valves and piston rings are common results of these deposits.

Fuel must have good lubricating qualities because injector and fuel pump parts are fuel lubricated. Fuels with a viscosity lower than 34 Saybolt (at 100° F.), or 2.4 Centistokes, are generally lacking in lubricating qualities. If it is necessary to use a "dry" fuel, it is advisable to add small quantities of lubricating oil to the fuel tank.

The fuel must have a pour point as low as the lowest ambient temperature encountered. To be safe, it is better to insist on a fuel with a pour point at least 10 degrees lower than the lowest anticipated temperature.

Gravity is an indication of the heat value, or Btu content, of fuel oil. Heavy fuel—low A.P.I. degree—contains more heat units per gallon than light fuel as indicated by a higher A.P.I. number. Heavy fuel is generally, but not always, associated with a high viscosity number and a high pour point. Viscosity is more important than gravity, and the viscosity number should never be below 34 Saybolt regardless of the gravity.

The cetane number is indicative of the ignition quality of the fuel. The fuel must have a higher cetaine rating for cold weather operation. We must never lose sight of the fact that a Diesel Engine fires from the heat of compression. Cold weather acts to lower the temperature of the compressed air in the combustion chamber because of lower ambient temperatures and slower cranking speeds.

Heavy fuels are more difficult to atomize than light fuels and require more time to burn. At high engine speed, the time available for complete combustion may be inadequate for complete burning of heavy fuel, and high exhaust temperatures, excessive carbon formation, exhaust smoke, etc., may result from the use of extremely heavy fuels, or fuels with a high percentage of heavy ends.

Bottom sediment often consists of abrasive materials which cause excessive wear of fuel pump and injector parts. Water fouls the fuel filter and causes rust and corrosion inside the fuel pump and injectors. Water combines with mineral acids, sometimes present in petroleum derivatives to increase corrosive action.

The fuel must not contain more than one per cent sulphur. When sulphur burns, it forms sulphur-oxygen compounds which will combine with steam or water to form sulphurous, or sulphuric acids. Water vapor is a natural product of combustion and is always present in the exhaust. Thus, if fuel contains excessive sulphur, all the necessary elements and conditions are present to make acids that will cause increased cylinder wear. If the acid compounds work past the piston rings and into the crankcase oil, main and connecting rod bearings will be ruined very quickly. Under certain conditions, sulphur, in quantities of less than one per cent, may cause extensive damage. In these cases, the sulphur combines with other elements to form gum and lacquer-like deposits on parts in the fuel system and combustion chamber.

Handling Fuel

It is just as necessary to protect fuel from dirt and water—after it is purchased—as it is to buy good fuel in the first place. Fuel should always be strained or filtered before being put into the supply tank. It is always easier—and cheaper—to remove dirt from fuel before it finds its ways into the fuel system. Straining or filtering fuel, before emptying it into the supply tank, will improve fuel filter life and reduce the chances of the dirt getting into the fuel pump.

Filter elements on the engine should be changed whenever they become dirty. With good fuel, the filter element supplied with the engine should be changed every 4000 gallons of fuel consumed. With poor or dirty fuel, the element must be changed oftener.

Fuel screens in the fuel pump and in the fuel inlet connections must be kept clean. Restrictions at these points will interfere with fuel delivery and limit horsepower output.

More condensation of water vapor occurs in partially filled than in full fuel tanks.

Fuel supply tanks and filter cases should be drained of all water and sediment at regular intervals. The fuel filter has a drain plug located at the bottom of the case. The fuel supply tank should be provided with a sump and drain plug or valve. In ordinary operations, draining is necessary about every 500 gallons fuel consumed.

One quart of denatured alcohol to each 50 gallons of fuel oil will help prevent water from freezing at the bottom of the tank during cold weather.

Fuel Line Piping

The fuel inlet and drain manifold should be checked occasionally for restrictions. Care must be taken to prevent the use of any sharp bends in the fuel piping to prevent vibration and breakage.

If any fuel line connections are removed, they should be washed thoroughly before removing and before reinstalling to prevent dirt from entering the fuel system.

THE COOLING SYSTEM

Engine Coolant

WATER TESTING AND TREATMENT: While water is the best coolant for use in an engine it sometimes contains impurities which contribute to corrosion, or others which build up as deposits and interfere with heat transference.

Corrosion or pitting in the water jacket area can be caused by chlorides, sulphates or acids. The presence of these impurities can be detected by any water testing laboratory, and after the type of impurity is known the proper treatment can be recommended to make the water suitable for use in the cooling system. Unfortunately, there is no single water treatment which will correct all undesirable conditions. The test is necessary before the proper treatment can be recommended.

CHROMATE COMPOUNDS: There are several chromate compounds on the market which are being used successfully to treat aggressive waters. They neutralize acidity and help in other ways to prevent corrosion.

Formerly, two objections were raised to the use of chromates: Careless handling sometimes resulted in skin eruptions and some compounds can not be used with anti-freezes. These objections do not apply to compounds now on the market in pellet or liquid form which are compatible with ethylene-glycol anti-freezes.

CUMMINS CORROSION RESISTOR: This is a unit which by-passes a small amount of coolant from the system through a filtering and treating device. It softens water, neutralizes acidity and protects against corrosion by the use of a replaceable chemically-activated filtering element. In addition the unit contains a sacrificial metal plate which arrests pitting of metals in the system by electro-chemical action. It is available as extra equipment from your Cummins Dealer and easily installed on any Cummins engine.

SOLUBLE OIL: Soluble oil acts to prevent entrainment of oxygen in the cooling system and in that manner it greatly retards or prevents rust and corrosion in engines except when the water is acid. Where used the mixture should be 3% to 4% soluble oil and 96% to 97% water.

Soluble oil can not be used with permanent-type anti-freezes.

ANTI-FREEZES: Anti-freezes should have a higher boiling point than water to avoid loss by evaporation; the preference is for the "permanent-type" anti-freezes with ethylene-glycol base properly compounded with corrosion inhibitor. Manufacturers of these types of anti-freezes which are already inhibited do not recommend the addition of soluble oil or other inhibitors in the coolant.

INHIBITORS MUST BE RENEWED: After a period of service—usually one season or less—the inhibitor loses some of its effectiveness. The effective period will vary with the type of water used and the cleanliness of the cooling system. Always follow the manufacturer's recommendations about renewal.

Temperature Controls

RADIATOR: Since operating temperatures are dependent on the efficiency of the cooling system, it is apparent that it should function at its best. If the radiator is allowed to become dirty outside or inside—it loses efficiency with detrimental effect on the engine. Dirt is a poor conductor of heat. Keep the radiator clean.

OIL COOLERS OR HEAT EXCHANGER: J, JS and JT engines have oil coolers as standard equipment. Marine engines also use a heat exchanger for water cooling. Where a heat exchanger is used, a sea water pump is used in conjunction with it.

The oil cooler acts as an oil heater to bring the lubricating oil temperature up to the water temperature, then it acts as a cooler to prevent a further temperature increase.

WATER TEMPERATURE: Ideal water temperature for best engine performance is 180° F. It should not exceed 195° F.

Do not stop the engine suddenly after a load run. Heat stored in the iron masses will boil the cooling water in the jackets if air and water circulation is immediately stopped while the engine is hot. Allow the engine to idle for a few minutes before shutting down.

Thermostats: Two main line and one by-pass thermostats are provided in the cooling system to maintain engine coolant temperatures 170° F. to 195° F. The thermostats must be maintained in good operating condition.

Main line thermostats open at 170° F. to 175° F. The by-pass thermostat closes at 190° F. to 195° F. Main line thermostats must always open at a lower temperature than the closing temperature of the by-pass thermostat. See Page 3-12 for method of checking opening and closing of thermostats.

Other Thermal Control Devices: Radiator shutters, variable pitch fans, etc., when used in conjunction with main line and by-pass thermostats in the engine, should be set to open at 175° F. and to close at 168° F.

OVERHEATING OF ENGINE: Overheating of the engine may be caused by any of the following conditions:

1. Insufficient amount of cooling water.
2. Clogging of cooling system.
3. Loose fan belts.
4. Insufficient amount or poor quality lubricating oil.
5. Improper valve clearances.
6. Overloading or too much fuel for the available air.
7. Exhaust back pressure.
8. Sludge or lime formation in cooling system.
9. Broken water pump.

J, JS, JT ENGINE SPECIFICATIONS

4-cycle, Valve-in-head, Full Diesel

Bore and stroke	4⅛ x 5
Compression ratio	
Model J	17.4 to 1
JS and JT	15.5 to 1
Cylinders	6
Firing order (Right hand)	1-5-3-6-2-4
Fuel oil specifications	See Page 3-23
Lubricating oil specifications	See Page 3-21
Lubricating oil pressure	
Normal @ governed speed	30 to 60 psi
Minimum @ idling	5 to 15 psi
Main and connecting rod bearings	
Copper-lead, steel backed, precision type	

Oil pan capacity—not including filters	
Low level	3 gallons
High level	4 gallons
Operating temperatures	
Water	160° F. to 195° F.
Lubricating oil	180° F. to 200° F.
Piston displacement	401 cu. in.
Rated horsepower	
	Maximum @ RPM
Model J	100 @ 2200
JS	150 @ 2500
JT	165 @ 2500
Valve and injector adjustment	Page 3-13

SECTION IV

Trouble Shooting

The term "trouble shooting" means locating the basic cause of the difficulty so that when repairs are made there will be no repetition of the failure. Trouble shooting, in most cases, is very simple. In the majority of problems the only requirement is a knowledge of the construction of the units and the principles of its operation. Knowing these two factors, anyone who is qualified to make repairs on the unit can start at the beginning and follow through each step in the functioning of each part until the cause of the trouble is found.

Trouble shooting is nothing more nor less than an organized study of the problem and a planned method of procedure for the investigation and correction of the difficulty. The following charts include some of the most common complaints that may be encountered during the service life of your J, JS or JT diesel engine.

These charts do not give all the answers for correction of the complaints listed, but they are meant to stimulate a train of thought and indicate a work procedure directed to the source of the trouble.

TROUBLE SHOOTING PROCEDURE

Think Before You Act:

Study the problem thoroughly. Ask these questions:

What were the warning signs preceding the trouble?

What previous repair and maintenance work has been done?

Has similar trouble occurred before?

If the engine still runs, is it safe to continue running it to make further checks?

Do Easiest Things First:

Most troubles are simple and easily corrected; examples are "low-power" complaints caused by loose throttle linkage or dirty fuel filters, "excessive lube oil consumption" caused by leaking gaskets or connections, etc.

Always check the easiest and most obvious things first; you will save time and trouble.

Double-Check Before You Begin Disassembly Operations:

The source of most engine troubles can be traced not to one part alone but to the relationship of one part with another. Too often, engines are completely disassembled in search of the cause of a certain complaint and all evidence is destroyed during disassembly operations. Check again to be sure you have not missed an easy solution to the problem.

Find and Correct the Basic Cause of the Trouble:

After a mechanical failure has been corrected, be sure to locate and correct the cause of the trouble so that the same failure will not repeat itself. A complaint of "sticking injector plungers" is corrected by repairing or replacing the faulty injectors, but something *caused* the plungers to stick. The cause may be improper injector adjustment, or more often, to water in the fuel.

Failure To Start

If the engine stops suddenly and will not start, or if the engine will not start after being shut down for several hours, the trouble is always due to one or more of the following conditions:

A. Fuel not being delivered to the cylinders in the right quantity or in the right condition to burn.

B. Air not being taken in to the cylinders or not being compressed sufficiently to provide the heat required to ignite the fuel.

C. A mechanical failure which locks or binds the engine and prevents it from being cranked and run.

Inability to crank or high temperatures indicate a mechanical failure. Practically all other cases of failure to start are due to the engine air or fuel systems.

CAUSE	REMEDY
Tanks out of fuel.	Fill all tanks connected to engine.
Fuel shut-down valve closed.	This occurs frequently. Always check for opening of valve.
Preheater inoperative or glow-plug too wet to ignite fuel.	Check glow plug and preheater connections. See Page 2-2.
	Do not overprime the preheater. Stop as soon as it catches its prime.
Suction leaks between tanks and pump.	Check all fittings for tightness as well as fuel filter can and gasket. Replace fittings as required. If fitting dope is required, use Crane Lead Sealer #2.
Suction air leaks at fuel pump.	Replace "O" ring seal on pressure regulator cap if mutilated. Tighten the cap to 20/25 ft. lbs.
Clogged fuel filter, lines or screens.	Check and clean if needed.
Insufficient cranking speed.	Check battery charge. Check battery cable connections. Tighten if loose. Always start engine spinning with compression released to relieve load on battery and to obtain higher cranking speed.
Water in fuel or poor grade fuel.	Drain water and sediment at fuel filter. See "Fuel Specifications," Page 3-23.
Low compression.	Check for sticking valves, worn rings, etc. Be sure the compression release lever is pushed in after the cranking motor starts the engine spinning.
Fuel pump pressure regulator plunger stuck open or spring left out.	See "PT Operation and Maintenance Manual," Bulletin No. 6370-A.
Suction lines and gear pump dry on initial installation.	Fill gear pump with clean lube oil to prime pump and suction lines. The fuel filter should be filled with fuel to start new system.

Engine Misses On One Or More Cylinders

When an engine "misses" or "skips" it is due to one or more cylinders not performing properly. A 150 horsepower six-cylinder engine is actually six 25 HP engines. If one cylinder is only 50% effective it will deliver only 12½ horsepower (instead of 25 HP) and the total maximum horsepower of the engine will be cut from 150 to 137½. This would cause a "miss" or "skip."

If the engine is to run smoothly and deliver full horsepower, these requirements must be met:

A. All cylinders must receive uniform quantities of fuel at the proper time.
B. All cylinders must receive uniform quantities of air.
C. All cylinders must have equal compression.
D. Fuel must be ignited at the proper time in each cylinder.

CAUSE	REMEDY
Water in fuel or poor grade fuel.	See fuel specifications, Page 3-23.
Suction air leaks in fuel system.	Check all fittings for tightness as well as fuel filter can and gasket. Replace fittings as required. If fitting dope is required use Crane Lead Sealer #2.
Incorrect adjustment of valves or injectors.	Adjust as instructed on Page 3-13.
Injector plunger sticking.	Repair or replace.
Dirty or damaged injector cup.	Clean or replace.
Valve (or valves) worn or sticking.	Free sticking valves or grind if worn.

Excessive Fuel Consumption

One important consideration in any "excessive fuel consumption" complaint is to determine whether the fault is due to the engine itself or to the manner in which the engine is operated. An overloaded engine will burn fuel at a proportion far in excess of the slight additional amount of work that may be obtained from doing so. Lugging the engine not only wastes fuel, but permits the wasted fuel to wash down the cylinder walls to dilute lubricating oil.

If it is definitely determined that the engine is burning too much fuel there is one important point to remember:

The ratio of air to fuel in the combustion chambers of a diesel engine is at such a proportion that the problem is not with too much air, but in being able to obtain a sufficient quantity of air for complete combustion of the fuel. Restriction of intake air, excessive exhaust back pressure or loss of air during the compression stroke of the piston have a direct effect on fuel consumption in relation to horsepower output.

CAUSE	REMEDY
Engine being lugged.	Always operate so you can accelerate to reach governed rpm.
Fuel connection, fitting or gasket leaks.	Check and repair.
Engine fuel rate set too high.	Have fuel pump recalibrated.
Poor fuel.	Use clean fuel without water or gasoline added. The fuel should be within Cummins fuel specifications.
Restricted air intake.	Check inlet connections for obstructions. Clean air cleaners.
Excessive exhaust back pressure.	Back pressure should be not over 1 inch of mercury for the J engine or 1.5 inches for JS and JT engines.
Incorrect adjustment of valves or injectors.	Adjust as instructed on Page 3-13.
Plugged injector cup spray holes or orifices.	The engine exhaust will be dark and the power will be low accompanied by low fuel mileage. Proper injector maintenance is required for good fuel mileage.
Leaking head gasket and engine valves.	Repair the damaged parts in the engine; trouble in the engine is often attributed to the fuel system.
Excessive oil in the crankcase.	Drain the crankcase to the proper level; never run the crankcase level above the high limit as the rods may dip in the oil and cause a loss of power transmitted from the engine.

Excessive Lube Oil Consumption

When an engine starts using oil, the first conclusion is usually "worn rings or liners." In jumping to this conclusion, many other causes of high lube oil consumption—much easier to remedy—have been overlooked. For example, a worn oil seal, a gasket leak, a loose fitting or even a dirty breather cap can cause an engine to lose several quarts of oil in just a few hours. Not until all other possibilities have been eliminated should an engine be torn down and overhauled because of an excessive lube oil consumption complaint.

CAUSE	REMEDY
External leaks.	Check and repair.
Poor grade lube oil.	See lubricating oil specifications, Page 3-21.
Crankcase temperature too high.	Temperature should be 180° F./200° F. under full-load conditions.
Dirty crankcase breather.	Clean and replace.
Loss to cooling system.	Check head gaskets, oil cooler, etc.
Worn or damaged oil seals.	Check crankshaft and camshaft oil seals.
Worn turbocharger bearings.	This may cause a rapid loss of lubricating oil. Have turbocharger rebuilt.
Worn pistons, rings or liners.	Check and replace if needed.
Excessive lubricating oil pressure.	Check pressure regulator for free action and wear.

Abnormal Coolant Temperatures

Abnormal operating temperature may be considered any temperature below 160° F. or any temperature above 195° F. Cooling systems of Cummins J, JS and JT Diesel Engines are designed to hold engine temperature within the normal range. To quickly bring a cold engine to operating temperature all circulation through the radiator is stopped by the main-line thermostats. At normal operating temperature, the main-line thermostats open to allow enough water to flow through the radiator to hold the temperature constant. Under adverse conditions or in extremely hot climates, the by-pass thermostats go into action to direct the entire coolant supply through the radiator to utilize all of its reserve capacity.

If, under normal load and average weather conditions, the temperature of the coolant remains either above or below the normal range, one of the conditions listed in the chart below is at fault.

CAUSE	REMEDY
Above Normal	
Insufficient coolant.	Keep cooling system filled.
Collapsed hose, or loose connections on suction side.	Check hose lines for internal collapse.
Worn water pump.	Repair or replace.
Loose fan belts.	Adjust or replace with new belts.
Main line thermostats stuck closed.	Clean or replace.
Scale deposit in block or heads.	Reverse flush cooling system to remove scale. Check soluble oil content.
Clogged radiator.	Flush with steam or approved cleaner.
Engine overload.	Do not load engine beyond recommended horsepower rating.
Below Normal	
Main line thermostats stuck open.	Clean or replace.
Weather conditions require radiator shutters or variable fan.	Install new shutters or new fan as required.

Excessive Engine Smoking

A smoky engine exhaust is a visible indication of incomplete burning of fuel or lubricating oil escaping past the piston rings and being blown out with the exhaust gasses. Incomplete burning may be due to one or more of the following conditions:

A. Fuel does not meet specifications.
B. Restriction of inlet air.
C. Engine overloaded.
D. Faulty fuel pump calibration.
E. Faulty injection.
F. Low operating temperature.
G. Low compression.

The color of the smoke from the engine exhaust may be an indication of the nature of the trouble. As a general rule, black or gray smoke indicates incomplete burning of the fuel and blue smoke indicates partial burning of lubricating oil. Variations in smoke volume or in atmospheric conditions may interfere with smoke analysis by color.

CAUSE	REMEDY
Black or Gray Smoke	
Engine fuel rate set above specified limit.	An overfueled engine will have a heavy exhaust and damage to the engine will result. Calibrate the fuel pump to specified limit for each model of engine.
Restriction of intake air.	Check air inlet restriction with manometer. See page 3-16. If restriction exceeds 18 inches of water at maximum governed rpm, clean air cleaner screens and piping.
Operation at high altitude or with hot intake air temperature.	Both high altitude and hot intake air decreases the air available to the engine. The air cleaner should be mounted to draw cool air into the engine and the engine fuel rate must be reduced for operating at high altitude.
Excessive exhaust back pressure.	Back pressure should be not more than 1 inch mercury for Model J engines or 1.5 inches for JS and JT engines.
Engine being lugged or overloaded.	Always operate so you can "find the governor." Avoid loads in excess of engine horsepower.
Obstructed fuel drain lines or drain manifold.	Poor deceleration may accompany this trouble. Check the drain connections, drain manifold and drain line for restrictions.
Plugged injector cups or injector orifices.	This complaint will be accompanied by low power, poor fuel mileage, etc. Clean injectors.

Excessive Engine Smoking (Cont'd)

CAUSE	REMEDY
Injectors set loose.	The plunger must seat firmly in the cup to prevent leakage and resulting smoke. Set injector at specified torque.
Cracked injector cup tip or worn spray holes.	Replace with rebuilt injector.
Poor grade of fuel.	See "Fuel Specifications," Page 3-23.
Blue Smoke—Presence of Lubricating Oil	
Worn oil rings, pistons or liners.	Install new rings. Check for scored liners or pistons.
Operating temperature too low.	See "Abnormal Operating Temperatures."
Valves not seating.	Free valves if possible or regrind.
White Smoke—Unburned Lubricating Oil	
Worn turbocharger bearings.	Rebuild turbocharger.

Excessive Engine Vibration

Engine vibration sometimes can be extremely dangerous even though it seems not to be excessive. An engine with an inoperative vibration damper, running at a critical rpm sets up a rythmic "firing order" vibration that harmonizes with the vibration of the engine as a whole. This harmony between the two types of vibration —if continued for any length of time—will increase in magnitude until the crankshaft snaps. This emphasizes the importance of thoroughly checking the vibration damper at any time an excessive engine vibration complaint occurs.

An unbalanced or loose flywheel, a weak cylinder, or an engine out of time are other likely causes of excessive engine vibration.

CAUSE	REMEDY
Engine operated at critical rpm.	Check rpm at which critical speed is reached, then check vibration damper.
Unbalanced or loose flywheel.	Have flywheel balanced or replaced.
Inoperative vibration damper.	Replace new.
One or more weak cylinders.	Check valves, rings and liners for wear.
Unbalanced crankshaft.	Repair or replace new.

Crankcase Sludge

The gummy deposits in the engine crankcase known as sludge can be eliminated almost entirely by using good quality lubricating oils and by proper engine maintenance. The most common cause of sludge is low operating temperatures. It is always a serious mistake to remove the engine thermostats during the summer months. Even in moderately warm weather an engine will not reach its most efficient operating temperature if the thermostats are removed.

Crankcase sludge can be avoided if the following requirements are met:

A. Use only the best quality lubricating oils.

B. Avoid long idling periods.

C. Keep thermostats in good working order.

Crankcase sludge is just another penalty of improper maintenance practices. Although it may not be considered as one of the most serious complaints, it does show that troubles such as these would not occur under a well planned preventive maintenance program.

CAUSE	REMEDY
Long idling periods.	Operating temperatures must be kept to 160° F./195° F.
Lube oil strainers not cleaned regularly.	Clean as instructed on Page 3-4.
Poor quality lube oil.	See lube oil specifications, Page 3-21.
Water temperature too low.	See "Abnormal Coolant Temperatures."
Worn rings, pistons or liners.	Engine due for overhaul.

Low Power

If an engine will not develop its rated horsepower, the condition is due to one of the following:

A. Restricted air supply.
B. Restricted fuel supply.
C. Incorrect mechanical adjustments.
D. Badly worn pistons, rings or liners.

In order to have a sufficient supply of oxygen to effectively burn its fuel, the diesel engine, at governed speed, must displace several hundred cubic feet of air per minute. This means that all air passages must be unobstructed, air filters must be clean and the exhaust piping must be free from sharp bends or obstructions.

Fuel filters and fuel lines must also be clean and free of obstructions. Except in those cases of extreme engine wear or faulty engine adjustments, lack of power can nearly always be traced to the air or fuel systems.

See Pages 6-9 to 6-11, PT Operation and Maintenance Manual, Bulletin No. 6370-A for additional information on low power complaints.

CAUSE	REMEDY
Dirty fuel filter.	Clean as instructed on Page 3-10.
Restricted air inlet.	Check inlet connections. Clean air filters.
Incorrect adjustment of throttle linkage.	Adjust linkage for proper idle and maximum speed positions.
Incorrect valve or injector adjustment.	See "Valve and Injector Adjustment," Page 3-13.
Clogged injector spray holes.	See "Cleaning Injectors," Page 3-16.
Leaky valves or injectors.	Adjust or grind valves. Repair or replace injectors.
Low compression.	Check for sticking valve, or worn rings and liners.
Improperly calibrated fuel pump.	Check on test stand.
Excessive blow-by (one or more cylinders).	Install new rings. Check for scored liners and pistons.

Chart No. 1

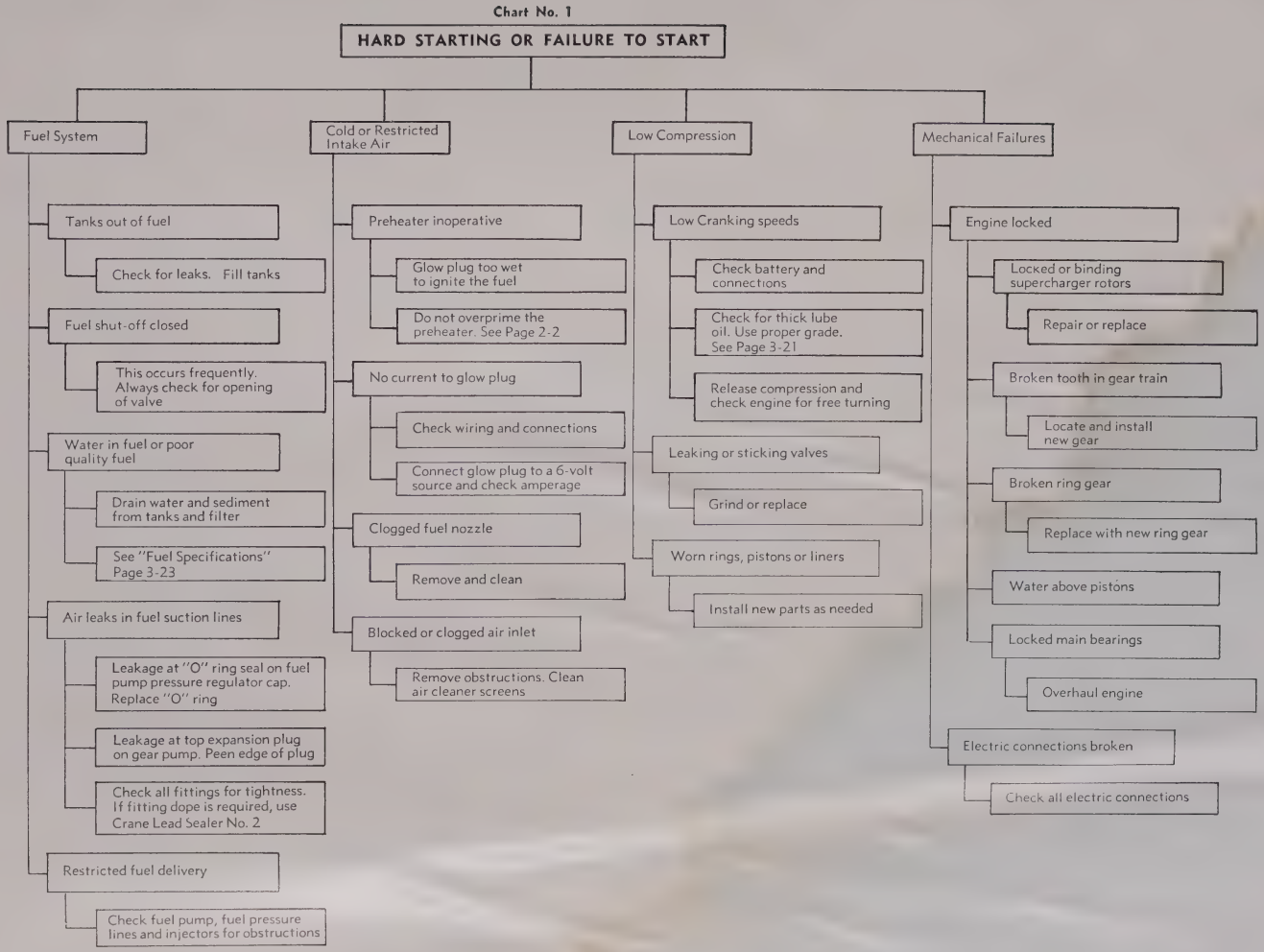

HARD STARTING OR FAILURE TO START
Fuel System
Tanks out of fuel
Check for leaks. Fill tanks
Fuel shut-off closed
This occurs frequently. Always check for opening of valve
Water in fuel or poor quality fuel
Drain water and sediment from tanks and filter
See "Fuel Specifications" Page 3-23
Air leaks in fuel suction lines
Leakage at "O" ring seal on fuel pump pressure regulator cap. Replace "O" ring
Leakage at top expansion plug on gear pump. Peen edge of plug
Check all fittings for tightness. If fitting dope is required, use Crane Lead Sealer No. 2
Restricted fuel delivery
Check fuel pump, fuel pressure lines and injectors for obstructions
Cold or Restricted Intake Air
Preheater inoperative
Glow plug too wet to ignite the fuel
Do not overprime the preheater. See Page 2-2
No current to glow plug
Check wiring and connections
Connect glow plug to a 6-volt source and check amperage
Clogged fuel nozzle
Remove and clean
Blocked or clogged air inlet
Remove obstructions. Clean air cleaner screens
Low Compression
Low Cranking speeds
Check battery and connections
Check for thick lube oil. Use proper grade. See Page 3-21
Release compression and check engine for free turning
Leaking or sticking valves
Grind or replace
Worn rings, pistons or liners
Install new parts as needed
Mechanical Failures
Engine locked
Locked or binding supercharger rotors
Repair or replace
Broken tooth in gear train
Locate and install new gear
Broken ring gear
Replace with new ring gear
Water above pistons
Locked main bearings
Overhaul engine
Electric connections broken
Check all electric connections

Chart No. 2

ENGINE MISSES ON ONE OR MORE CYLINDERS

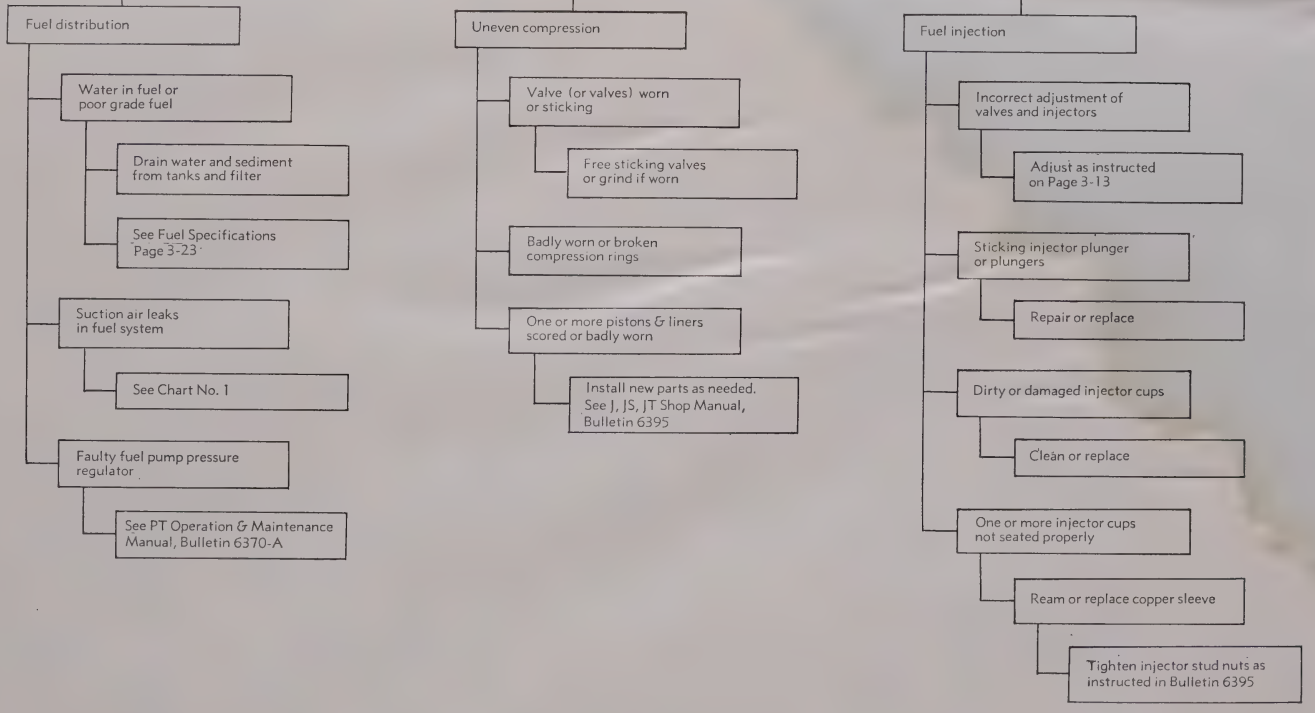

Fuel distribution
Water in fuel or poor grade fuel
Drain water and sediment from tanks and filter
See Fuel Specifications Page 3-23
Suction air leaks in fuel system
See Chart No. 1
Faulty fuel pump pressure regulator
See PT Operation & Maintenance Manual, Bulletin 6370-A
Uneven compression
Valve (or valves) worn or sticking
Free sticking valves or grind if worn
Badly worn or broken compression rings
One or more pistons & liners scored or badly worn
Install new parts as needed. See J, JS, JT Shop Manual, Bulletin 6395
Fuel injection
Incorrect adjustment of valves and injectors
Adjust as instructed on Page 3-13
Sticking injector plunger or plungers
Repair or replace
Dirty or damaged injector cups
Clean or replace
One or more injector cups not seated properly
Ream or replace copper sleeve
Tighten injector stud nuts as instructed in Bulletin 6395

Chart No. 3

EXCESSIVE FUEL CONSUMPTION

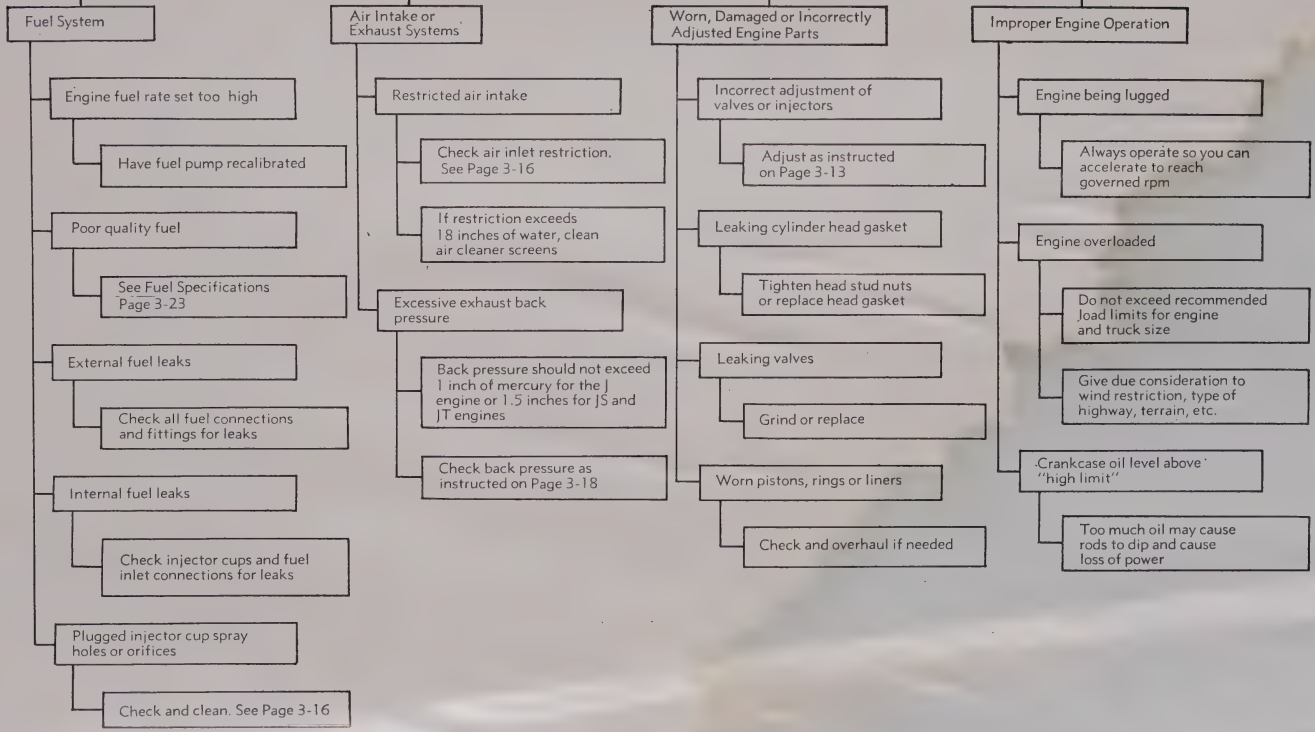

Fuel System
Engine fuel rate set too high
Have fuel pump recalibrated
Poor quality fuel
See Fuel Specifications Page 3-23
External fuel leaks
Check all fuel connections and fittings for leaks
Internal fuel leaks
Check injector cups and fuel inlet connections for leaks
Plugged injector cup spray holes or orifices
Check and clean. See Page 3-16
Air Intake or Exhaust Systems
Restricted air intake
Check air inlet restriction. See Page 3-16
If restriction exceeds 18 inches of water, clean air cleaner screens
Excessive exhaust back pressure
Back pressure should not exceed 1 inch of mercury for the J engine or 1.5 inches for JS and JT engines
Check back pressure as instructed on Page 3-18
Worn, Damaged or Incorrectly Adjusted Engine Parts
Incorrect adjustment of valves or injectors
Adjust as instructed on Page 3-13
Leaking cylinder head gasket
Tighten head stud nuts or replace head gasket
Leaking valves
Grind or replace
Worn pistons, rings or liners
Check and overhaul if needed
Improper Engine Operation
Engine being lugged
Always operate so you can accelerate to reach governed rpm
Engine overloaded
Do not exceed recommended load limits for engine and truck size
Give due consideration to wind restriction, type of highway, terrain, etc.
Crankcase oil level above "high limit"
Too much oil may cause rods to dip and cause loss of power

Chart No. 4

EXCESSIVE LUBRICATING OIL CONSUMPTION

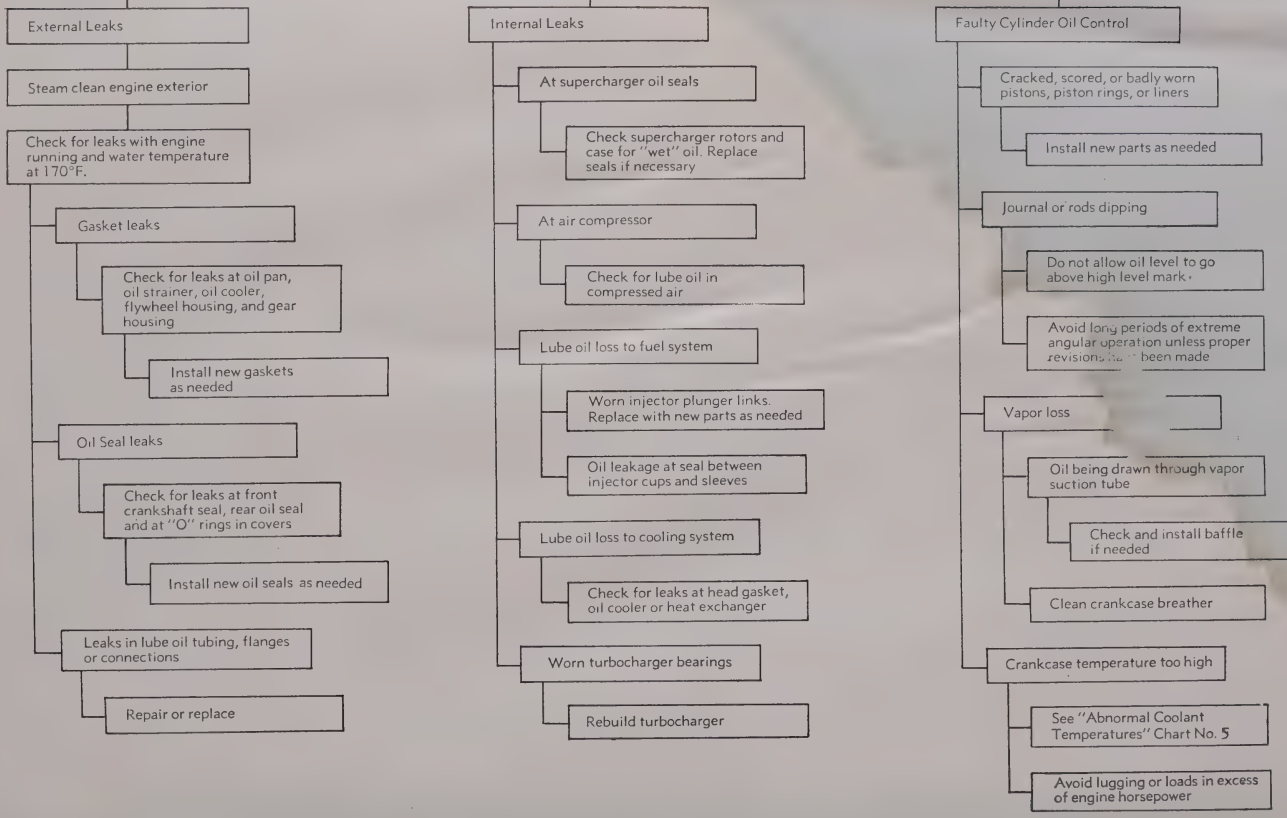

External Leaks
Steam clean engine exterior
Check for leaks with engine running and water temperature at 170°F.
Gasket leaks
Check for leaks at oil pan, oil strainer, oil cooler, flywheel housing, and gear housing
Install new gaskets as needed
Oil Seal leaks
Check for leaks at front crankshaft seal, rear oil seal and at "O" rings in covers
Install new oil seals as needed
Leaks in lube oil tubing, flanges or connections
Repair or replace
Internal Leaks
At supercharger oil seals
Check supercharger rotors and case for "wet" oil. Replace seals if necessary
At air compressor
Check for lube oil in compressed air
Lube oil loss to fuel system
Worn injector plunger links. Replace with new parts as needed
Oil leakage at seal between injector cups and sleeves
Lube oil loss to cooling system
Check for leaks at head gasket, oil cooler or heat exchanger
Worn turbocharger bearings
Rebuild turbocharger
Faulty Cylinder Oil Control
Cracked, scored, or badly worn pistons, piston rings, or liners
Install new parts as needed
Journal or rods dipping
Do not allow oil level to go above high level mark.
Avoid long periods of extreme angular operation unless proper revisions have been made
Vapor loss
Oil being drawn through vapor suction tube
Check and install baffle if needed
Clean crankcase breather
Crankcase temperature too high
See "Abnormal Coolant Temperatures" Chart No. 5
Avoid lugging or loads in excess of engine horsepower

Chart No. 5

ABNORMAL COOLANT TEMPERATURES

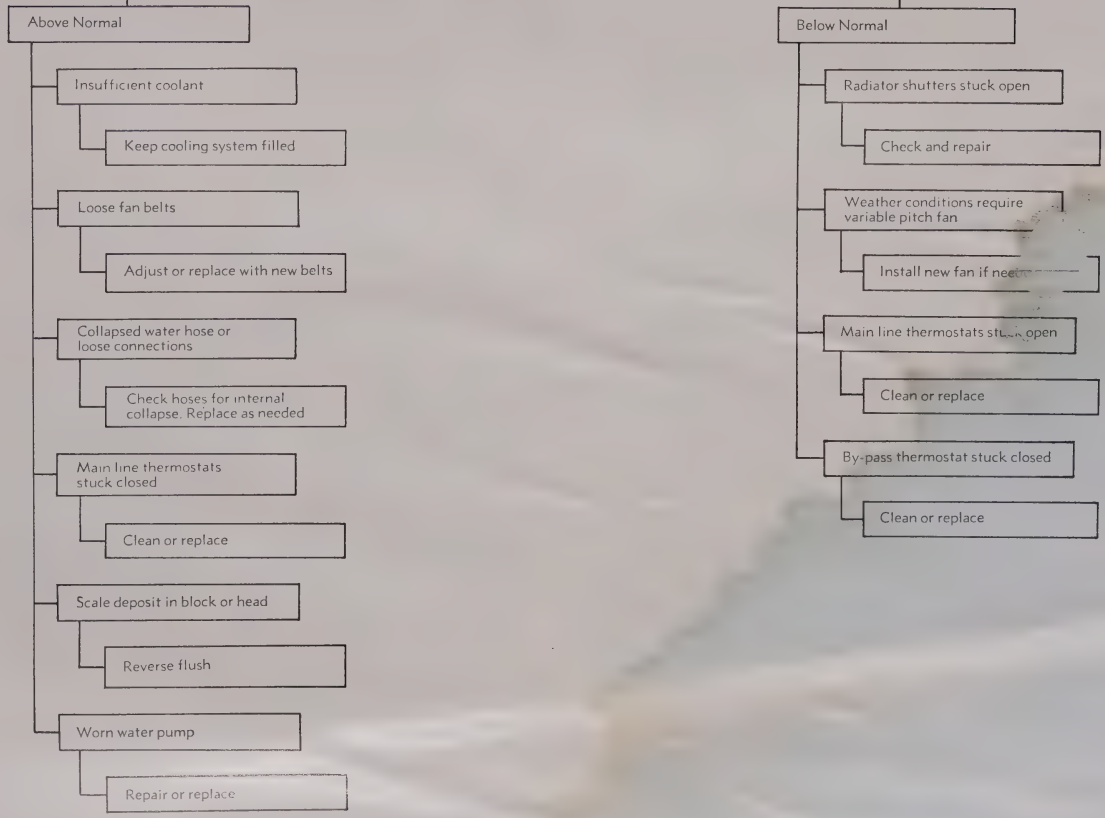

Above Normal
Insufficient coolant
Keep cooling system filled
Loose fan belts
Adjust or replace with new belts
Collapsed water hose or loose connections
Check hoses for internal collapse. Replace as needed
Main line thermostats stuck closed
Clean or replace
Scale deposit in block or head
Reverse flush
Worn water pump
Repair or replace
Below Normal
Radiator shutters stuck open
Check and repair
Weather conditions require variable pitch fan
Install new fan if nec
Main line thermostats st open
Clean or replace
By-pass thermostat stuck closed
Clean or replace

Chart No. 6

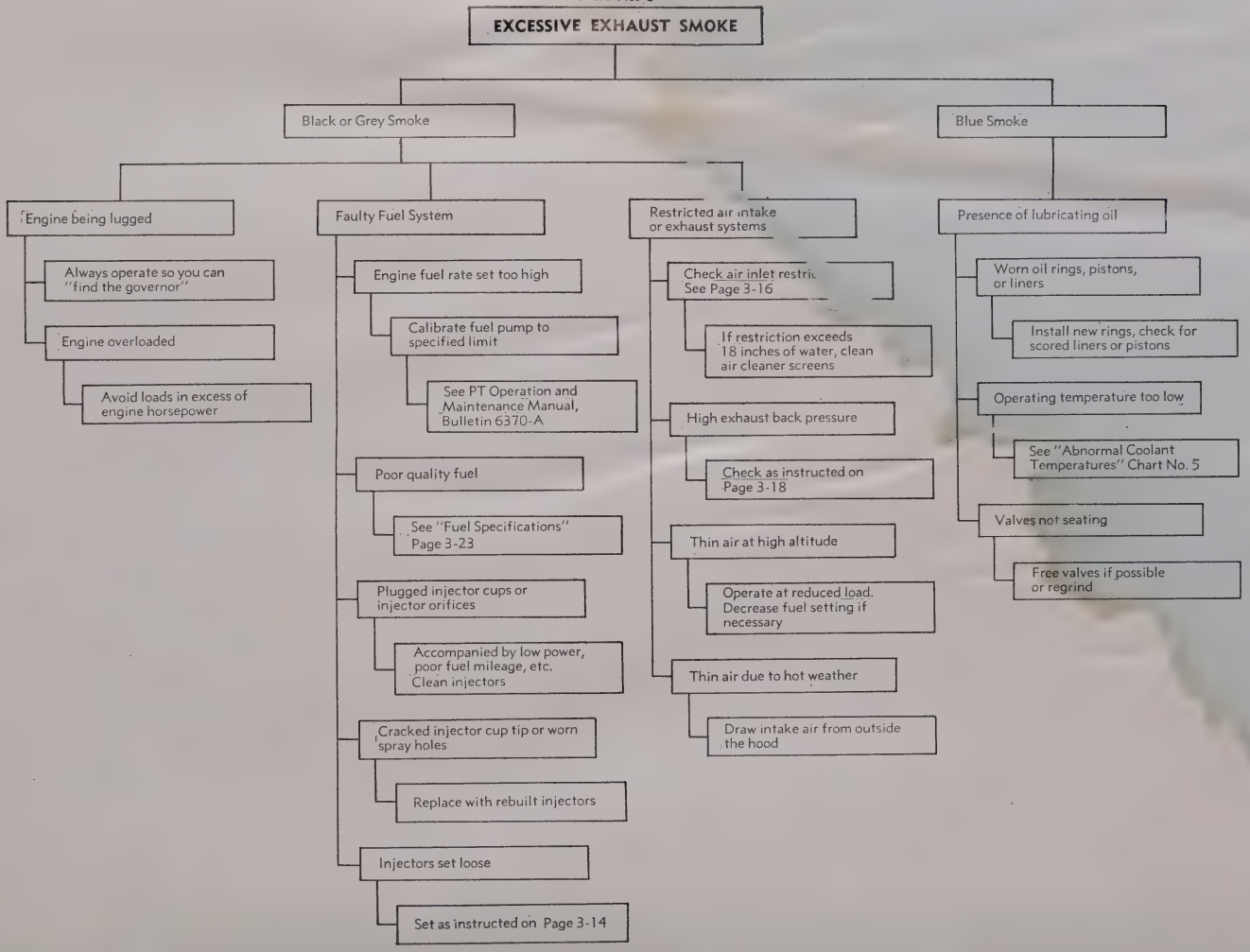

EXCESSIVE EXHAUST SMOKE
Black or Grey Smoke
Blue Smoke
Engine being lugged
Always operate so you can "find the governor"
Engine overloaded
Avoid loads in excess of engine horsepower
Faulty Fuel System
Engine fuel rate set too high
Calibrate fuel pump to specified limit
See PT Operation and Maintenance Manual, Bulletin 6370-A
Poor quality fuel
See "Fuel Specifications" Page 3-23
Plugged injector cups or injector orifices
Accompanied by low power, poor fuel mileage, etc. Clean injectors
Cracked injector cup tip or worn spray holes
Replace with rebuilt injectors
Injectors set loose
Set as instructed on Page 3-14
Restricted air intake or exhaust systems
Check air inlet restri
See Page 3-16
If restriction exceeds 18 inches of water, clean air cleaner screens
High exhaust back pressure
Check as instructed on Page 3-18
Thin air at high altitude
Operate at reduced load. Decrease fuel setting if necessary
Thin air due to hot weather
Draw intake air from outside the hood
Presence of lubricating oil
Worn oil rings, pistons, or liners
Install new rings, check for scored liners or pistons
Operating temperature too low
See "Abnormal Coolant Temperatures" Chart No. 5
Valves not seating
Free valves if possible or regrind

Chart No. 7

EXCESSIVE VIBRATION

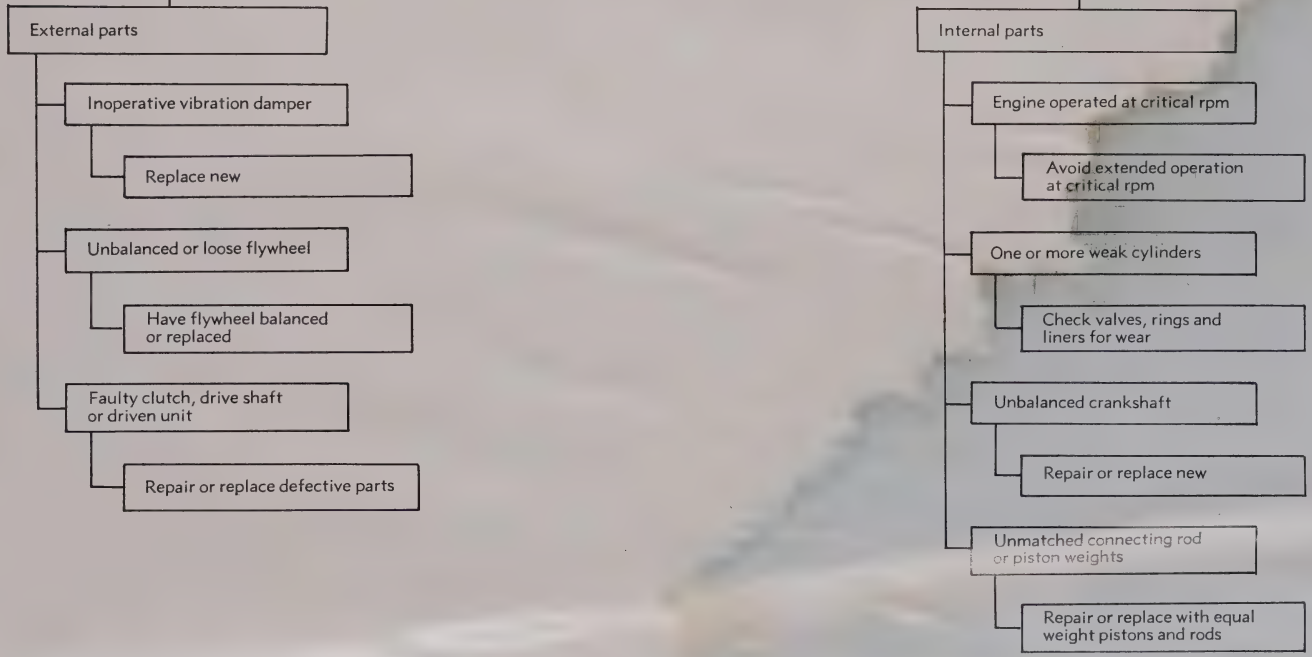

External parts
Inoperative vibration damper
Replace new
Unbalanced or loose flywheel
Have flywheel balanced or replaced
Faulty clutch, drive shaft or driven unit
Repair or replace defective parts
Internal parts
Engine operated at critical rpm
Avoid extended operation at critical rpm
One or more weak cylinders
Check valves, rings and liners for wear
Unbalanced crankshaft
Repair or replace new
Unmatched connecting rod or piston weights
Repair or replace with equal weight pistons and rods

Chart No. 8

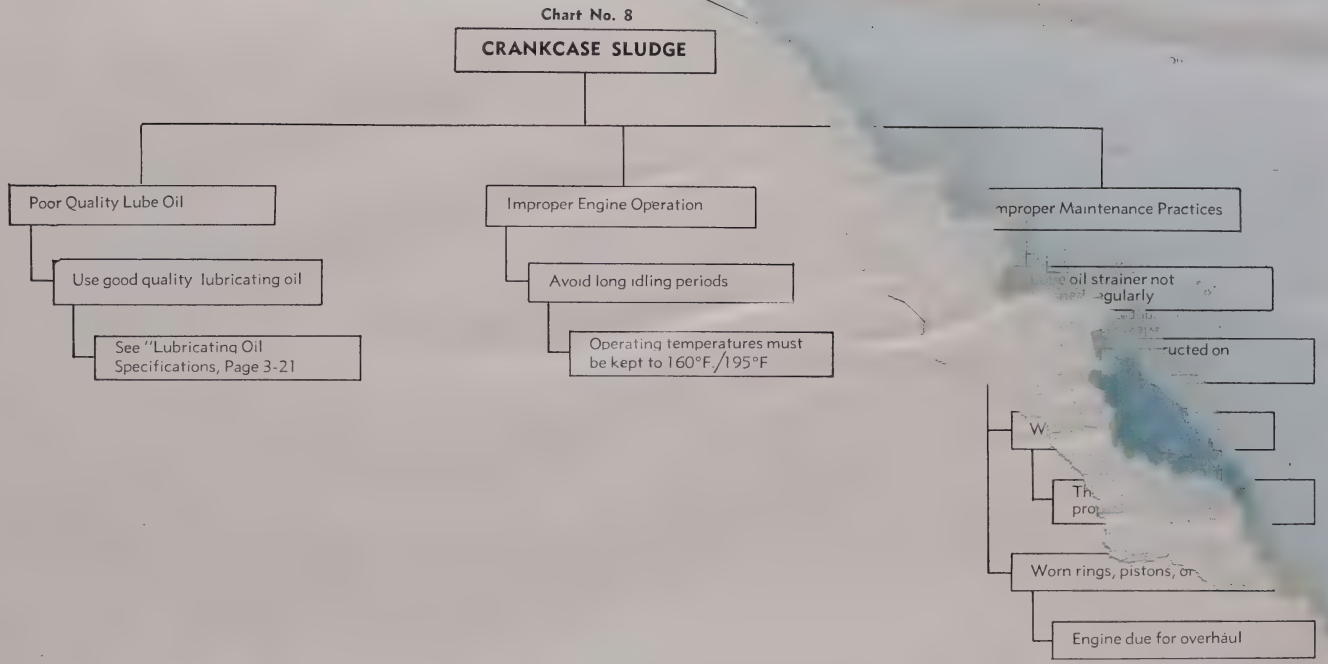
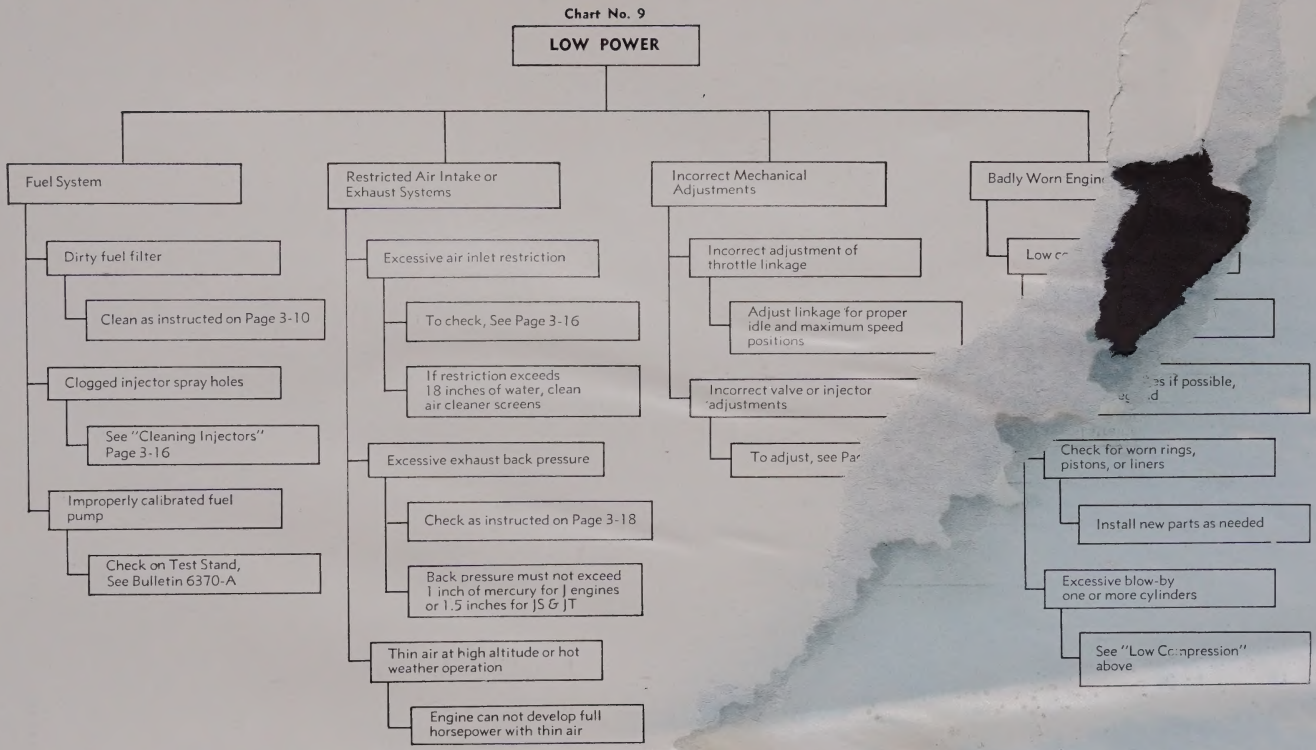

CRANKCASE SLUDGE
Poor Quality Lube Oil
Use good quality lubricating oil
See "Lubricating Oil Specifications, Page 3-21
Improper Engine Operation
Avoid long idling periods
Operating temperatures must be kept to 160°F./195°F
mproper Maintenance Practices
oil strainer not
gularly
ucted on
W
Th
pro
Worn rings, pistons, or
Engine due for overhaul

Chart No. 9


LOW POWER
Fuel System
Dirty fuel filter
Clean as instructed on Page 3-10
Clogged injector spray holes
See "Cleaning Injectors" Page 3-16
Improperly calibrated fuel pump
Check on Test Stand, See Bulletin 6370-A
Restricted Air Intake or Exhaust Systems
Excessive air inlet restriction
To check, See Page 3-16
If restriction exceeds 18 inches of water, clean air cleaner screens
Excessive exhaust back pressure
Check as instructed on Page 3-18
Back pressure must not exceed 1 inch of mercury for J engines or 1.5 inches for JS & JT
Thin air at high altitude or hot weather operation
Engine can not develop full horsepower with thin air
Incorrect Mechanical Adjustments
Incorrect adjustment of throttle linkage
Adjust linkage for proper idle and maximum speed positions
Incorrect valve or injector adjustments
To adjust, see Par
Badly Worn Engin
Low c
s if possible,
d
Check for worn rings, pistons, or liners
Install new parts as needed
Excessive blow-by one or more cylinders
See "Low Compression" above

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